

Effectiveness of the Internet-based Versus Face-to-Face Interaction on Reduction of Tobacco use among Adults: A Systematic Review and Meta-Analysis

Rajesh Kumar

All India Institute of Medical Sciences (AIIMS), Rishikesh, Uttarakhand, India 249203

<https://orcid.org/0000-0002-7504-5620>

Ravi Kant

All India Institute of Medical Sciences (AIIMS), Rishikesh, Uttarakhand, India 249203

<https://orcid.org/0000-0003-1144-4478>

Poonam Yadav (✉ dryadavpoonam257@gmail.com)

All India Institute of Medical Sciences (AIIMS), Rishikesh, Uttarakhand, India 249203

<https://orcid.org/0000-0003-0045-6588>

Tamar Rodney

Johns Hopkins School of Nursing, University of Maryland, Baltimore, MD, USA 21205

<https://orcid.org/0000-0002-0187-985X>

Mukesh Bairwa

All India Institute of Medical Sciences (AIIMS), Rishikesh, Uttarakhand, India 249203

<https://orcid.org/0000-0002-8974-5775>

Systematic Review

Keywords: Internet use, meta-analysis, Smoking cessation, systematic review, Tobacco

Posted Date: March 12th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-318627/v1>

License:  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Effectiveness of the Internet-based Versus Face-to-Face Interaction on Reduction of Tobacco use among Adults: A Systematic Review and Meta-Analysis

Rajesh Kumar¹, Ravi Kant², Poonam Yadav^{3*}, Tamar Rodney⁴, Mukesh Bairwa⁵

¹Assistant Professor, College of Nursing, All India Institute of Medical Sciences (AIIMS), Rishikesh, Uttarakhand, India 249203, rajeshrak61@gmail.com

²Additional Professor, Department of Internal Medicine, All India Institute of Medical Sciences (AIIMS), Rishikesh, Uttarakhand, India 249203, drkanttr2006@gmail.com

³Ph.D. Scholar, College of Nursing, All India Institute of Medical Sciences (AIIMS), Rishikesh, Uttarakhand, India 249203, dryadavpoonam257@gmail.com

⁴Assistant Professor, Johns Hopkins School of Nursing, University of Maryland, Baltimore, MD, USA 21205, trodney1@jhmi.edu

⁵Assistant Professor, Department of Internal Medicine, All India Institute of Medical Sciences (AIIMS), Rishikesh, Uttarakhand, India 249203, drmukeshbairwa1982@gmail.com

***Corresponding author-** Poonam Yadav, Ph.D. Scholar, College of Nursing, All India Institute of Medical Sciences (AIIMS), Rishikesh, Uttarakhand, India 249203, dryadavpoonam257@gmail.com, ORCID ID-0000-0003-0045-6588

Abstract

Background

The burden of tobacco-associated disorders is prevalent worldwide. Over the years, many innovative internet-based approaches have been utilized with variable success to quit tobacco. Though, the effectiveness of internet based and face-to-face interventions on quitting smoking are very well reported in the literature, but due to limitation in methodology and limited sample size, it is required to integrate and analyze these studies' findings to reach a single conclusion. The study evaluated the effectiveness of the internet as an intervention approach versus face-to-face interaction on reducing tobacco use as control among adults.

Methods

A systematic search was performed through various electronic databases such as Medline, PsychInfo, PubMed, Embase, Cochrane Central Register of Controlled Trials (CENTRAL), ResearchGate, Google Scholar, and Academia. Reference lists of the eligible articles were also screened. Full-text articles were included as per eligibility criteria (PICO framework). No ethnicity restriction was applied.

Results

A total of 13 studies were selected for meta-analysis, with 3852 and 3908 participants in intervention and control groups respectively. Forest plot favours the intervention group at one month follow up for tobacco quitting (OR: 2.37, CI: 1.86-3.02, $P=0.00001$, $I^2=0\%$), at three months (OR: 1.88, CI: 1.48-2.40, $P=0.00001$, $I^2=42\%$) at six months (OR: 2.02, CI: 1.64-2.50, $P=0.00001$, $I^2=38\%$) and at 1 year of follow-up (OR: 1.43, CI: 1.18-1.74, $P=0.00001$, $I^2=36\%$) comparing to control group.

Conclusion

Internet and web-based interventions are highly useful in tobacco quitting at one month, three months, six months, and one year of follow-up compared to face-to-face interaction or no intervention, although the level of evidence was moderate. Additionally, limited availability of trials in developing countries, arising need for research of internet use in developing countries to quit tobacco.

Keywords: Internet use, meta-analysis, Smoking cessation, systematic review, Tobacco.

Prospero Registration number- PROSPERO 2020 CRD42020214306

Introduction

Tobacco use is the leading cause of avertible and premature deaths worldwide.^[1,2] Burden of tobacco-related disease is increasing in developed and developing countries as well.^[3] Interestingly, the deaths are declining in developed countries, and the burden is shifting to developing countries.^[4] However, tobacco consumption pattern varies across gender; male

vs. female, domicile; rural vs. urban, regions, cultural practices, and family income.^[5] Men are more frequently (23%) indulging in tobacco use than their counterparts (3%).^[6] Quitting any form of smoking is challenging and involves physiological, psychological, and many other factors, including social and environmental milieu.^[7, 8] to become successful. In case of smoking cessation, the best use of positive and

negative reinforcements helps to alleviate the withdrawal symptoms and the role of behavioral approaches in smoking cessation cannot be denied.^[9, 10]

Over the years, many innovative forms of internet-based approaches have been tried to quit tobacco use globally. The use of health communication and internet-based interventions,^[11,12] tailored computerized programs,^[13] text messages,^[14] mobile or telephone, and WhatsApp for reminder or call,^[15-18] app-based intervention,^[19] chat-based instant messaging,^[20] video assistance using the website and mobile^[8] and use of social media,^[21] has been vividly used in recent decades to quit smoking among different age groups. Although there is ample research and data regarding the potential influence of the media,^[22] face to face health education,^[23] cognitive behavior therapy,^[5,23] motivational influences,^[6] nurses assisted counseling,^[24, 25] on behavioral changes among smokers, there are scanty reports on the internet use, or behavioral interventions. They are neither planned nor conducted rigorously to indicate firm evidence of any encouraging effects on health outcomes.^[26]

Interestingly, the use of the internet and other electronic platforms are abundantly present in this era and have almost become the part and parcel of the health care system.^[26] A medical expert with just a computer device and internet access and some necessary handling skills can reach many people and communicate inexpensively. Though, the effectiveness of internet based and face-to-face interventions on quitting smoking are very well reported in the literature, every study carries one or another limitation in methodology and limited sample size. Therefore, it is required to integrate and analyze these studies' findings to reach a single conclusion. This study was planned to assess the effectiveness of the internet versus face-to-face interactions on reducing tobacco use among adults.

Aim- To study the effectiveness of the internet versus face-to-face interventions on reducing tobacco use among adults.

Material and methods

Data sources and search strategy

The electronic databases, such as Medline, PsychInfo, PubMed, Embase, Cochrane Central Register of Controlled Trials (CENTRAL), Google Scholar, ResearchGate, and Academia, were explored. Reference lists of the eligible articles were also screened. All relevant studies

available on the topic were included irrespective of time duration. The systematic search was restricted to studies published in the English language. The keywords were "smoker or smokers OR smoking," "tobacco" OR cigarette OR nicotine OR smoking cessation OR "tobacco consumption OR cessation, OR abstain* OR quit* OR stop* OR computer OR computer-aided design, OR internet, OR computer, OR networks, OR media, OR cellular phone OR mobile, OR text OR message* OR SMS, OR web, OR electronic mail OR Chat, OR video recording.

Eligibility criteria

PICO Framework

Participants

Inclusion: Adult aged more than 18 years who use the internet or face-to-face interventions to reduce or quit tobacco use. No ethnicity restrictions were applied.

Exclusion: Cochrane studies that compare the internet to face-to-face interventions with other interventions.

Intervention

Internet interventions (Phone, mobile, WhatsApp, Facebook, Online network group, Online Support group, text messaging, other internet media)

Comparator

Face-to-face interventions or no intervention in the comparator group.

Face-to-face interventions include counseling, cognitive behavior therapy, or health education forms with control or routine care.

Outcome

Post-intervention tobacco quitting – number of participants quitting tobacco after the intervention (internet use)

Study design

Randomized controlled trials

Time frame

No restriction to the time frame was applied

Screening of eligible studies

A systematic search was done by two reviewers independently. After searching, studies were screened with titles and abstracts of respective studies. All selected studies were imported to Rayyan (<https://rayyan.qcri.org>), a free web-based software.^[27] Two reviewers screened the full text of articles based on eligibility criteria determined as per review protocol. Any relevant discrepancy has been resolved by consensus with the help of third reviewer. We adhered to the guidelines of Preferred Reporting Items for Systematic Review and Meta-Analysis

(PRISMA) 2009. [28] (Additional File. 1) PRISMA flow chart displays all the steps

followed in inclusion and exclusion of studies (Figure 1).

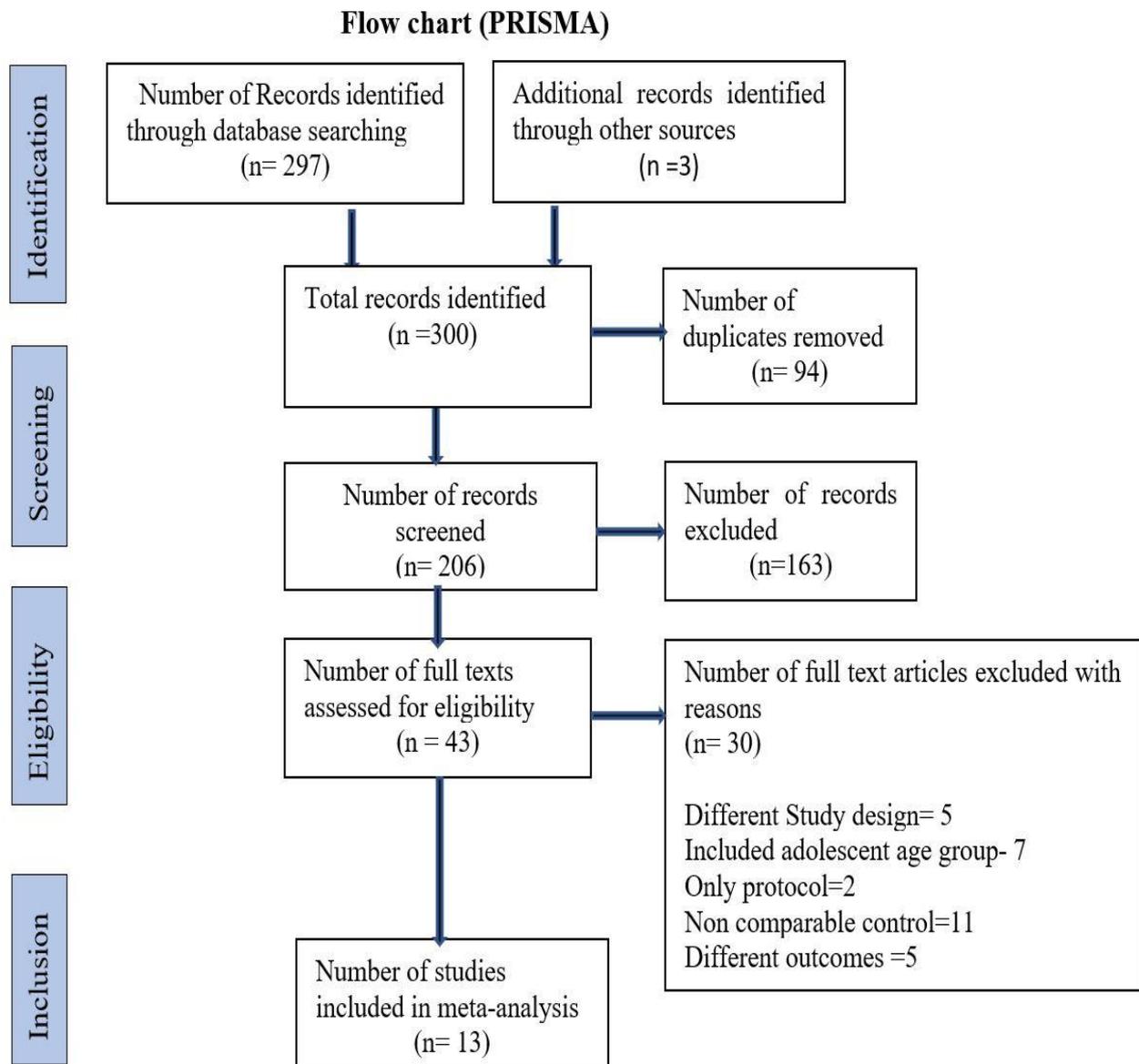


Figure 1 Flow chart (PRISMA)

Data extraction

Two reviewers extracted the data from the full text of eligible studies. Corresponding authors of included studies were contacted for the relevant data. Data excel sheet was prepared to note the characteristics of selected studies. It includes the author name with publication year, country, sample size, the mean age of participants, male to female ratio, baseline

tobacco consumption, and follow-up period after the intervention (Table 1).

Eligible studies were exported to RevMan software for data analysis. Forest plots have been created to present the results with Odds ratio (OR), confidence interval (CI), and effect size.

Table 1 Baseline characteristics of included studies							
Author/Year	Country	Interventions	Sample size Intervention/control group	Mean age of participants (years)	Intervention/Control group Male/Female (%)	Baseline Cigarette Consumption	Follow up
Brendryen (A), 2008 ^[31]	Norway	A digital multi-media intervention consists of more than 400 contacts by email, Web pages, interactive voice response, and short message service technology	200/200 smokers	Intervention- 35.9 ± 10.0 Control-36.4± 10.5	Intervention- 49.2/50.8 % Control- 50.2/49.8 (%)	Intervention 18.3 ± 5.9 Control 18.1 ± 5.8 cigs/day	1,3.6 and 12 months
Brendryen (B), 2008 ^[32]	Norway	A digital multi-media intervention consists of more than 400 contacts by email, Web pages, interactive voice response, and short message service technology without nicotine therapy	144/146 smokers	Intervention- 39.5 ± 11 Control- 39.7± 10.8	Intervention- 50/50 (%) Control- 50/50 (%)	Intervention: 16.6 ± 7.2 Control 17.6 ± 7 cigs/day	1,3.6 and 12 months
Burford, 2013 ^[33]	Australia	A computer-generated photoaging intervention with no treatment group	80/80 smokers	Intervention- 24.2 ± 4.1 Control- 25.1 ± 4.1	Intervention- 31.3/68.7 (%) Control- 43.8/56.2 (%)	Range- <1- <21 Intervention- 36.3% smoked 11-20 cigs/day Control- 33.8% smoked 11-20 cigs/day	6 months
Clark, 2004 ^[34]	United States	Internet resources for smoking cessation compared with written self-help material	85/86 smokers	Intervention- 57.8 ± 5.2 Control-57.0 ± 5.3	Intervention- 54/46 (%) Control- 48/52 (%)	Range- <10- <31 Intervention- 48% smoked 11-20 cigs/day Control-44% smoked 11-20 cigs/day	One year
Calhoun 2016 ^[35]	United States	Internet intervention and tele-health medication clinic combined with a tele-health medication clinic for nicotine replacement therapy	205/203 smokers	Intervention- 43.3 ± 13.6 Control- 42.6 ± 14.3	Intervention- 85/15 (%) Control- 84/16 (%)	Intervention- Control-15.7 ± 8.8 14.6 ± 8.5	3 months and 12 months

Elfeddali, 2012 ^[36]	Netherlands	Web-based computer-tailored programs	190/202	Intervention- 40.75 ± 11.48 Control- 40.68 ± 11.81	Intervention- 36.7/ 63.3 (%) Control- 40.1/ 59.9 (%)	Intervention- 19.89 ± 9.36) Control- 19.85 ± 8.39	Twelve months
Japuntich, 2006 ^[37]	United States	Web site which provided information on smoking cessation as well as support	140/144 smokers	Intervention- 40.6±12.4 Control-41.0± 11.8	Intervention- 45/55 (%) Control- 45.1/54.9 (%)	Intervention- 21.1 ± 9.5 Control- 22.1± 10.2	Six months
Lawrence, 2008 ^[38]	United States	Personalized smoking cessation through an online life magazine	257/260 smokers	Intervention- 20.1± 1.6 Control-19.8± 1.6	Intervention- 24.6/75.4 (%) Control- 29.6/70.4 (%)	Intervention- 3.8 ± 4.7) Control-4.2 ± 5.0	Thirty weeks
McDonnell, 2010 ^[39]	Korea	Internet self-help smoking cessation programme	272/315 Smokers	Total 35 years (mean)	Total- 12/88 (%)	Total- 14 cigs/smoking day	Twelve months
Oenema, 2008 ^[40]	Netherlands	An internet delivered computer tailored lifestyle intervention	1080/1079 smokers	Intervention- 43.1± 10.4 Control-44.1± 10.4	Intervention- 46/54 (%) Control- 47/53 (%)	NA	One month
Pisinger, 2010 ^[41]	Denmark	Interactive, individual advice, newly developed by the Research Centre	476/442 smokers	Intervention- 49.63 ±16 Control-46.97 ±17	Intervention- 36.8/63.2 (%) Control- 36.6/63.4 (%)	Intervention - 18.12 ±10 Control- 16.25 ±8	Twelve months
Smit, 2012 ^[42]	Netherlands	A multiple computer-tailored smoking cessation intervention through the Internet	552/571	Intervention- 48.4 ±12.2 Control-48.8 ±12.3	Intervention- 45.8/ 54.2 (%) Control- 49.4/ 50.6 (%)	Intervention - 20.8 ±13.7 Control- 20.4 ± 11	1 month and 6 months
Swartz, 2006 ^[43]	United States	A video based internet site that presented current strategies for smoking cessation and motivational materials	171/180 smokers	Intervention- 18-70 years (range) Control-18-70 years (range)	Intervention- 46.8/53.2 (%) Control- 8.9/50.6 (%)	Range <16- >31; 32.3% smoked 16-20 cigs/day	1 month

Risk of bias assessment

Two reviewers independently assessed the quality of included studies was. Risk of bias graph and summary has been created in Review Manager software 5.4 version under the heads of Random sequence generation (selection bias), Blinding of participants and personnel

(performance bias), Allocation concealment (selection bias), Blinding of outcome assessment, (detection bias), Selective reporting (reporting bias), Incomplete outcome data (attrition bias), and Other bias (Figure 2).^[29]

The GRADE approach was also followed to explore the quality of evidence on high,

moderate, and low levels. [30] RevMan files were exported to the GRADE Profiler to assess the

quality of studies and create a "Summary of Findings" table (Table 2).

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Certainty of the evidence (GRADE)
	Events in control group	Events in Internet intervention group			
Tobacco quit at 1 month follow up	105 per 1,000	217 per 1,000 (179 to 261)	OR 2.37 (1.86 to 3.02)	2531 (5 RCTs)	⊕⊕⊕○ MODERATE ^a
Tobacco quit at 3 months follow up	164 per 1,000	269 per 1,000 (225 to 320)	OR 1.88 (1.48 to 2.40)	1733 (5 RCTs)	⊕⊕⊕○ MODERATE ^b
Tobacco quit at 6 months follow up	125 per 1,000	224 per 1,000 (190 to 263)	OR 2.02 (1.64 to 2.50)	2774 (6 RCTs)	⊕⊕⊕○ MODERATE ^a
Tobacco quit at one year follow up	187 per 1,000	248 per 1,000 (214 to 286)	OR 1.43 (1.18 to 1.74)	2757 (6 RCTs)	⊕⊕⊕○ MODERATE

a. Wide confidence interval
b. Heterogeneity

Data analysis

Review Manager software 5.4 version was used for Meta-analysis. [29] The fixed-effects model and effect measures were calculated as the OR with P-value < 0.05 considered statistically significant. I² statistics with 25, 50, and 75 % were measured to compute statistical heterogeneity in low, moderate, and high grades. Tabulated data presented in a forest plot (Figure 3).

The Funnel plots have also been created to assess the publication bias across studies. It measures an effect estimate against its standard error for an outcome (Figure 4).

Tobacco quitting among participants has been analyzed at one, three, six, and twelve months of follow-up and presented in a forest plot (Figure 3).

Results

A total of 13 articles were found suitable for meta-analysis, with 3852 and 3908 participants in intervention and control groups. [31-43] All studies revealed data with a sample size ranging from 160^[33] to 2159^[40]. Baseline characteristics of included studies have been described in table 1. All studies have nearly equal male and female participants. Only two studies Lawrence et al. and Pisinger et al. had majority of female participants (Intervention-75.4 % / Control-70.4

%) and (Intervention-63.2 % Control-63.4 %) respectively. [38, 41] Calhoun et al. had the majority of male participants in the intervention (85%) and control group (84 %). [35]

Two studies measured the outcome at four steps: one, three, six months, and one year. [31, 32] Two studies followed up the participants only for one month. [40, 43] Two studies measured the outcome at six months only. [33, 37] Calhoun et al. measured the outcome at three months and twelve months of internet intervention and tele-health medication clinic unite with a tele-health medication clinic for nicotine replacement therapy. [35] Even four studies assessed the outcome of tobacco use at one year of different web or internet-based intervention. [34, 36, 39, 41]

Subgroup analysis with tobacco quitting outcomes at one, three, six months, and one-year follow-up further lowers the heterogeneity across studies. Sensitivity analysis was done to find the better result with a random effect model. We observed similar results with the random effect model also. Pike KJ et al. have been removed from the analysis due to the huge difference in number of participants in both groups, creating heterogeneity. [44]

The Forest plot favors the intervention group (OR: 2.37, CI: 1.86-3.02, P=0.00001, I²=0%) in

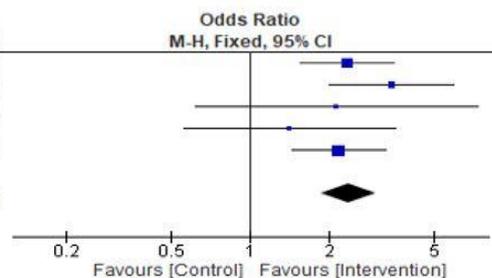
comparison to the control group for quitting tobacco at a one-month follow-up (**Figure 3**). The Forest plot also favors the intervention group compared to the control group (OR: 1.88, CI: 1.48-2.40, P=0.00001, I²=42%) for quitting tobacco at three months follow up (**Figure 3**). The Forest plot also favors the intervention group compared to the control group (OR: 2.02, CI: 1.64-2.50, P=0.00001, I²=38%) for quitting tobacco at six months follow up (**Figure 3**).

The Forest plot also favors the intervention group compared to the control group (OR: 1.43, CI: 1.18-1.74, P=0.00001, I²=36%) for quitting tobacco at one year follow up (**Figure 3**). The forest plot suggests significantly higher tobacco quitting events in the internet intervention group at one, three, six, and twelve months of follow-up of participants with moderate heterogeneity across the studies.

Figure 3 Forest plot comparing internet intervention with the control group

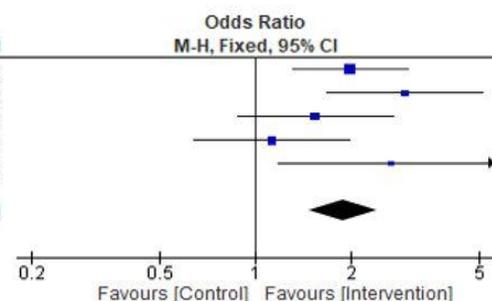
Tobacco quit at 1 month follow up

Study or Subgroup	Intervention		Control		Weight	Odds Ratio M-H, Fixed, 95% CI
	Events	Total	Events	Total		
Brendryen (A) 2008	99	200	59	200	33.9%	2.34 [1.55, 3.53]
Brendryen (B) 2008	60	144	25	146	16.5%	3.46 [2.01, 5.95]
Clark 2003	8	85	4	86	4.1%	2.13 [0.62, 7.36]
Oenema 2008	11	272	8	275	8.7%	1.41 [0.56, 3.55]
Smit 2012	74	552	38	571	36.8%	2.17 [1.44, 3.27]
Total (95% CI)		1253		1278	100.0%	2.37 [1.86, 3.02]
Total events	252		134			
Heterogeneity: Chi ² = 3.28, df = 4 (P = 0.51); I ² = 0%						
Test for overall effect: Z = 7.01 (P < 0.00001)						



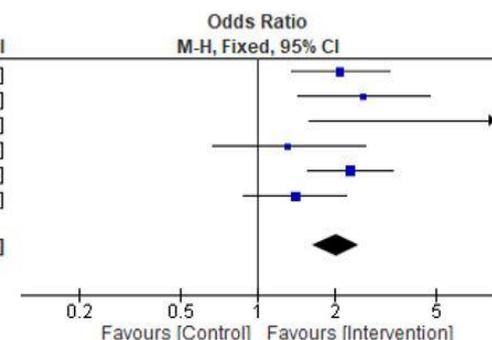
Tobacco quit at 3 months follow up

Study or Subgroup	Intervention		Control		Weight	Odds Ratio M-H, Fixed, 95% CI
	Events	Total	Events	Total		
Brendryen (A) 2008	88	200	57	200	32.8%	1.97 [1.30, 2.99]
Brendryen (B) 2008	51	144	23	146	15.2%	2.93 [1.67, 5.14]
Calhoun 2016	35	205	24	203	20.6%	1.54 [0.88, 2.69]
Japuntich 2006	32	140	30	144	23.5%	1.13 [0.64, 1.98]
Swartz 2006	21	171	9	180	7.9%	2.66 [1.18, 5.99]
Total (95% CI)		860		873	100.0%	1.88 [1.48, 2.40]
Total events	227		143			
Heterogeneity: Chi ² = 6.85, df = 4 (P = 0.14); I ² = 42%						
Test for overall effect: Z = 5.14 (P < 0.00001)						



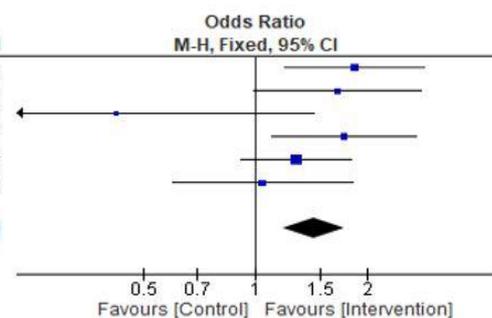
Tobacco quit at 6 months follow up

Study or Subgroup	Intervention		Control		Weight	Odds Ratio M-H, Fixed, 95% CI
	Events	Total	Events	Total		
Brendryen (A) 2008	73	200	43	200	22.3%	2.10 [1.35, 3.27]
Brendryen (B) 2008	42	144	20	146	11.5%	2.59 [1.43, 4.69]
Burford 2013	11	80	1	80	0.7%	12.59 [1.59, 100.05]
Japuntich 2006	21	140	17	144	11.6%	1.32 [0.66, 2.62]
Lawrence 2008	105	257	60	260	28.8%	2.30 [1.57, 3.37]
Smit 2012	45	552	34	571	25.1%	1.40 [0.88, 2.22]
Total (95% CI)		1373		1401	100.0%	2.02 [1.64, 2.50]
Total events	297		175			
Heterogeneity: Chi ² = 8.06, df = 5 (P = 0.15); I ² = 38%						
Test for overall effect: Z = 6.52 (P < 0.00001)						



Tobacco quit at one year follow up

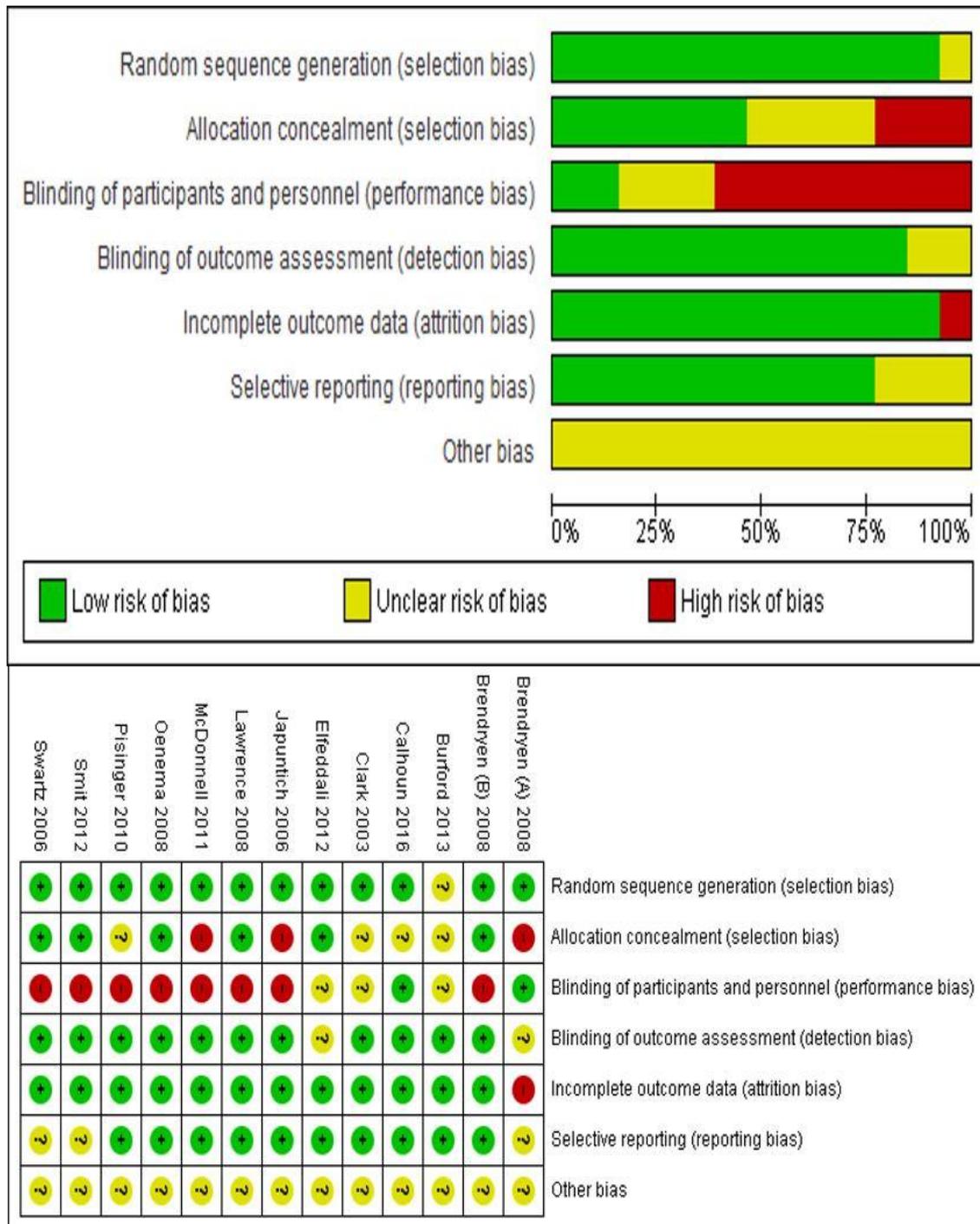
Study or Subgroup	Intervention		Control		Weight	Odds Ratio M-H, Fixed, 95% CI
	Events	Total	Events	Total		
Brendryen (A) 2008	74	200	48	199	17.6%	1.85 [1.20, 2.85]
Brendryen (B) 2008	47	144	33	146	12.8%	1.66 [0.99, 2.79]
Clark 2003	4	85	9	86	4.9%	0.42 [0.12, 1.43]
Elfeddali 2012	63	190	45	202	16.9%	1.73 [1.11, 2.71]
McDonnell 2011	102	272	100	315	33.6%	1.29 [0.92, 1.81]
Pisinger 2010	28	476	25	442	14.2%	1.04 [0.60, 1.82]
Total (95% CI)		1367		1390	100.0%	1.43 [1.18, 1.74]
Total events	318		260			
Heterogeneity: Chi ² = 7.79, df = 5 (P = 0.17); I ² = 36%						
Test for overall effect: Z = 3.64 (P = 0.0003)						



Risk of bias has been assessed and created a risk of bias graph, and summary of included studies under the heads of selection bias, performance bias, detection bias, attrition bias, reporting bias, and any other bias observed across the studies. It depicts that there was no serious risk of bias across the studies (Figure 2).

bias, and any other bias observed across the studies. It depicts that there was no serious risk of bias across the studies (Figure 2).

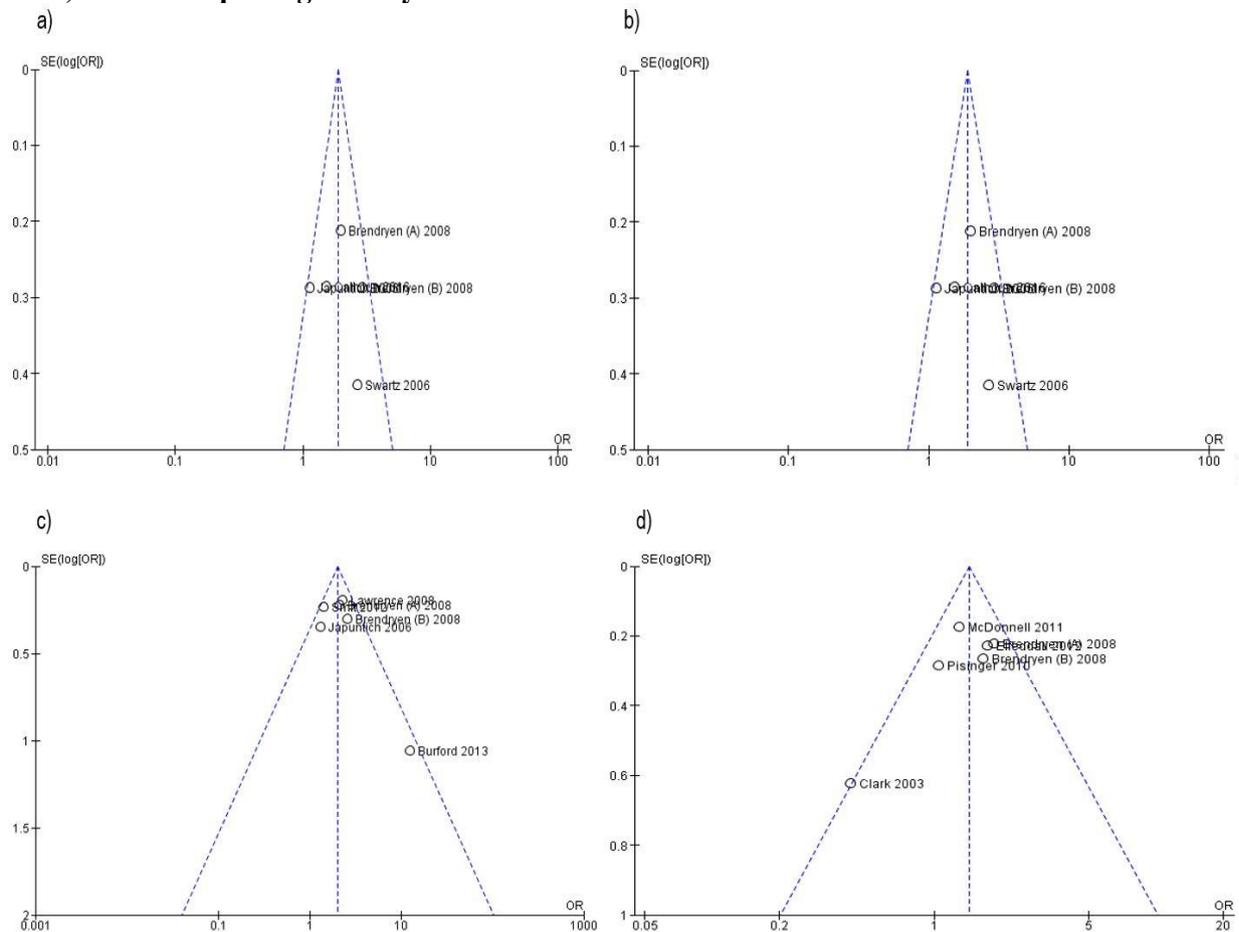
Figure 2 Risk of bias graph and summary



A funnel plot has been created to estimate the effect against its standard error for included studies in each outcome (Figure 4).

Figure 4 Funnel plot: shows publication bias across studies for each outcome.

- a) Tobacco quitting at one month
- b) Tobacco quitting at three months
- c) Tobacco quitting at six months
- d) Tobacco quitting at one year



Discussion

Over the year, many innovative forms of internet-based approaches^[11] tailored computerized programs,^[13] text messages,^[14] mobile or telephone, and WhatsApp for reminder or call,^[15–18] app-based intervention,^[19] chat-based instant messaging,^[20] video assistance using the website and mobile^[8] and use of social media,^[21] have been practiced commonly to quit tobacco in different age group population. Although, various methodological issues reduce the ability to estimate the effects of internet-based approaches.

This study evaluated the impact of the internet approaches versus face-to-face interaction on reducing tobacco use in adult population. Results suggestive of significantly higher tobacco quitting events in the internet intervention group than the control group at one month, three months, six months, and one year

of follow-up of participants with moderate heterogeneity across the studies. Happy ending, a digital multi-media smoking cessation intervention consists of more than 400 contacts through emails, interactive voice response, Web pages, and short message service compared with self-help booklet, reported higher point abstinence rates in the treatment group in the long-term effect of the intervention.^[31, 32]

A written list of internet resources for smoking cessation was found more useful than written self-help material to quit smoking for a long-term period of one year.^[34] Internet-based self-help smoking cessation program, interactive, individual advice, multiple computer-tailored smoking cessation internet interventions, and a video-based internet site presented strategies for motivational materials and smoking cessation found no effect at six months of intervention but the significant effect at 12 months of follow up.^[39, 41, 42, 43]

Personalized smoking cessation through an online life magazine in young population enhanced smoking cessation at the end of 12 months. [38]

Internet use and telehealth medication clinic combined with a telehealth medication clinic for nicotine replacement therapy reported no significant difference (17% vs. 12%) in comparison to clinical-based smoking cessation after three months of intervention. [35] However, Burford O et al. compared a computer-generated photoaging intervention with no treatment group and reported a higher (27.5%) incidence of smoking quit than the control group (6.3%) at six months follow up. [33] Rabius V et al. reported the follow-up response rate as 38%, and Feil EG et al. achieved 50% responses from participants with monetary incentives. [45, 46] Findings were also reinforced by the researchers that the participants' loss inevitably influences research on the internet for health purposes. [47, 48] After the quit attempts, web-based interventions could be more effective in preventing relapse in the long term, which requires adherence to the intervention for its effectiveness. [36]

Additionally, approach to a website supporting smoking abstinence is not related to smoking cessation. [37] Civiljak M et al. reported the strong effect of uniting tailored materials with nicotine replacement therapy on tobacco cessation and a significant positive impact of tailored materials among pre-contemplators. [49] Previous studies compared the tailored to untailored web-based intervention; few studies have observed that tailored web-based intervention is equally efficacious to untailored intervention [50-55], while others have found the tailored intervention to be better in comparison to untailored one. [40, 56, 57]

The internet services should be based on their preference and easily accessible to them who want to quit smoking and seek related information through the internet, need to utilize the internet services for the same. [58] Presently,

Acknowledgement: None

Conflict of interest: None declared

Financial disclosure: Nil

Contributions details

Study conception/design: Yadav P, Kumar R

Data extraction, analysis, and interpretation: Yadav P, Kumar R, Kant R

Drafting Manuscript: Yadav P

Revising manuscript: Yadav P, Kumar R, Kant R, Rodney T, Bairwa M

Approval of final version of the manuscript for publication: Yadav P, Kumar R, Kant R, Rodney T, Bairwa M

internet interventions' incremental cost is less than other modalities, facilitating and evaluating online programs for effectiveness.

[59] Online interventions also can access smokers and support them in quitting tobacco, which is also firmly associated with the total and physical quality of life among adults. [59, 60] Despite variations in trials, this meta-analysis adds to the evidence for promising approach of the internet-based intervention in modifying behavior, reducing tobacco use and enhancing positive health practices among adults.

Strength and limitations

Sub group analysis explored and discussed the possibility of tobacco quitting in adult population at different time points. Sensitivity analysis strengthened the evidence by exploring possible alternate findings.

Although, there was lack of uniformity of internet-based approaches in included trials as they had different internet approaches which have been discussed also. (Table 1) Risk of included bias in individual trial also contributed towards the limitation of meta-analysis. (Figure 2)

Conclusion

This meta-analysis pooled the data of randomized controlled trials with a limited sample size and wind up that internet use is highly effective in tobacco quitting at one, three, six, and twelve months of follow-up of participants in comparison to face-to-face intervention or no intervention with moderate heterogeneity across the studies and a moderate level of evidence to support the findings. Further studies are required to explore internet interventions' durable adherence among the adult population who their spared maximum time with internet in any form. Additionally, limited availability of trials in developing countries, arising need for research of internet use in developing countries to quit tobacco. Findings provide evidence to policymakers to utilize the internet as an effective instrument for tobacco control in their countries.

References

- [1]. Peto R, Lopez AD, Boreham J, Thun M, Heath CJ, Doll R. Mortality from smoking worldwide. *British medical bulletin* 1996;52:12–21.
- [2]. Lopez AD. Video Q&A: Tobacco-related mortality: past, present, and future. An interview with Alan Lopez. *BMC Medicine* [Internet] 2014;12:162. Available from: <https://doi.org/10.1186/s12916-014-0162-x>
- [3]. Esson KM, Leeder SR, Initiative WHOTF. The Millennium Development Goals and tobacco control : an opportunity for global partnership / Katharine M. Esson, Stephen R. Leeder. 2004;
- [4]. World Health Organisation (WHO). WHOReport on the Global Tobacco Epidemic, 2008: The MPOWER Package, [internet]. Switzerland: 2008. Available from: https://www.who.int/tobacco/mpower/mpower_report_full_2008.pdf
- [5]. Ng M, Freeman MK, Fleming TD, Robinson M, Dwyer-Lindgren L, Thomson B, et al. Smoking Prevalence and Cigarette Consumption in 187 Countries, 1980-2012. *JAMA* [Internet] 2014;311:183–92. Available from: <https://doi.org/10.1001/jama.2013.284692>
- [6]. Grills NJ, Singh R, Singh R, Martin BC. Tobacco Usage in Uttarakhand: A Dangerous Combination of High Prevalence, Widespread Ignorance, and Resistance to Quitting. *BioMed Research International* [Internet] 2015;2015:132120. Available from: <https://doi.org/10.1155/2015/132120>
- [7]. Martínez-Vispo C, Rodríguez-Cano R, López-Durán A, Senra C, Fernández Del Río E, Becoña E. Cognitive-behavioral treatment with behavioral activation for smoking cessation: Randomized controlled trial. *PloS one* 2019;14:e0214252.
- [8]. Laland KN, Rendell L. Social Learning: Theory [Internet]. In: Choe JC, editor. *Encyclopedia of Animal Behavior* (Second Edition). Oxford: Academic Press; 2010. page 380–6. Available from: <http://www.sciencedirect.com/science/article/pii/B9780128132517000572>
- [9]. Baker TB, Brandon TH, Chassin L. Motivational Influences on Cigarette Smoking. *Annual Review of Psychology* [Internet] 2004;55:463–91. Available from: <https://doi.org/10.1146/annurev.psych.55.090902.142054>
- [10]. Audrain-McGovern J, Rodriguez D, Rodgers K, Cuevas J. Declining alternative reinforcers link depression to young adult smoking. *Addiction* [Internet] 2011;106:178–87. Available from: <https://doi.org/10.1111/j.1360-0443.2010.03113.x>
- [11]. Cassell MM, Jackson C, Chevront B. Health communication on the internet: an effective channel for health behavior change? *Journal of health communication* 1998;3:71–9.
- [12]. Takahashi Y, Satomura K, Miyagishima K, Nakahara T, Higashiyama A, Iwai K, et al. A new smoking cessation programme using the internet. *Tobacco control* 1999;8:109–10.
- [13]. Etter JF, Perneger T V. Effectiveness of a computer-tailored smoking cessation program: a randomized trial. *Archives of internal medicine* 2001;161:2596–601.
- [14]. Liao Y, Wu Q, Kelly BC, Zhang F, Tang YY, Wang Q, et al. effectiveness of a text-messaging-based smoking cessation intervention ("Happy Quit") for smoking cessation in China: A randomized controlled trial. *PLoS Medicine* 2018;15:1–18.
- [15]. Durmaz S, Ergin I, Durusoy R, Hassoy H, Caliskan A, Okyay P. WhatsApp embedded in routine service delivery for smoking cessation: effects on abstinence rates in a randomized controlled study. *BMC Public Health* 2019;19:387.
- [16]. Cheung YTD, Chan CHH, Lai C-KJ, Chan WFV, Wang MP, Li HCW, et al. Using WhatsApp and Facebook Online Social Groups for Smoking Relapse Prevention for Recent Quitters: A Pilot Pragmatic Cluster Randomized Controlled Trial. *Journal of medical Internet research* 2015;17:e238.
- [17]. Zhu S-H, Anderson CM, Tedeschi GJ, Rosbrook B, Johnson CE, Byrd M, et al. evidence of real-world effectiveness of a telephone quitline for smokers. *The New England journal of medicine* 2002;347:1087–93.
- [18]. Whittaker R, McRobbie H, Bullen C, Rodgers A, Gu Y, Dobson R. Mobile phone text messaging and app-based interventions for smoking cessation. *Cochrane Database of Systematic Reviews* [Internet] 2019; Available from: <https://doi.org/10.1002/14651858.CD006611.pub5>
- [19]. Wang MP, Luk TT, Wu Y, Li WH, Cheung DY, Kwong AC, et al. Chat-based instant messaging support integrated with brief interventions for smoking cessation: a community-based, pragmatic, cluster-randomised controlled trial. *The Lancet Digital Health* [Internet] 2019;1:e183–92.

Available from: <http://www.sciencedirect.com/science/article/pii/S2589750019300822>

- [20]. Naslund JA, Kim SJ, Aschbrenner KA, McCulloch LJ, Brunette MF, Dallery J, et al. Systematic review of social media interventions for smoking cessation. *Addictive behaviors* 2017;73:81–93.
- [21]. Langley TE, McNeill A, Lewis S, Szatkowski L, Quinn C. The impact of media campaigns on smoking cessation activity: a structural vector autoregression analysis. *Addiction* 2012;107:2043–50.
- [22]. Reddy UK, Siyo RKN, Ul Haque MA, Basavaraja H, Acharya BLG, Divakar DD. Effectiveness of health education and behavioral intervention for tobacco de-addiction among degree students: A clinical trial. *Journal of International Society of Preventive & Community Dentistry* 2015;5:S93–100.
- [23]. Hollis JF, Lichtenstein E, Vogt TM, Stevens VJ, Biglan A. Nurse-assisted counseling for smokers in primary care. *Annals of internal medicine* 1993;118:521–5.
- [24]. Bessell TL, McDonald S, Silagy CA, Anderson JN, Hiller JE, Sansom LN. Do Internet interventions for consumers cause more harm than good? A systematic review. *Health expectations: an international journal of public participation in health care and health policy* 2002;5:28–37.
- [25]. Haokip HR, Kumar R, Singh Rawat V, Sharma SK. Efficacy of standard nicotine replacement therapy (NRT) versus video-assisted nurse-led NRT on tobacco cessation: A randomized controlled pilot trial. *Clinical Epidemiology and Global Health* 2021;9:141–6.
- [26]. Mansoor I. The medical uses of internet and how to stay current with internet. *Journal of family & community medicine* 2002;9:63–4.
- [27]. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan — a web and mobile app for systematic reviews. *Sys Rev* 2016; 5:210.
- [28]. Moher D, Liberati A, Tetzlaff J, Altman DG, Group TP. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Med* 2009;6: e1000097.
- [29]. RevMan. Review Manager. 53rd ed. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration; 2014.
- [30]. GRADEpro: GRADEpro. Hamilton: McMaster University; 2014.
- [31]. Brendryen H, Kraft P. Happy ending: a randomized controlled trial of a digital multi-media smoking cessation intervention. *Addiction*. 2008 Mar;103(3):478-84; discussion 485-6.
- [32]. Brendryen H, Drozd F, Kraft P. A digital smoking cessation program delivered through internet and cell phone without nicotine replacement (happy ending): randomized controlled trial. *J Med Internet Res*. 2008 Nov 28;10(5):e51.
- [33]. Burford O, Jiwa M, Carter O, Parsons R, Hendrie D. Internet-based photoaging within Australian pharmacies to promote smoking cessation: randomized controlled trial. *J Med Internet Res*. 2013 Mar 26;15(3):e64.
- [34]. Clark MM, Cox LS, Jett JR, Patten CA, Schroeder DR, Nirelli LM, Vickers K, Hurt RD, Swensen SJ. Effectiveness of smoking cessation self-help materials in a lung cancer screening population. *Lung Cancer*. 2004 Apr;44(1):13-21.
- [35]. Calhoun PS, Datta S, Olsen M, Smith VA, Moore SD, Hair LP, Dedert EA, Kirby A, Dennis M, Beckham JC, Bastian LA. Comparative Effectiveness of an Internet-Based Smoking Cessation Intervention Versus Clinic-Based Specialty Care for Veterans. *J Subst Abuse Treat*. 2016 Oct;69:19-27.
- [36]. Elfeddali I, Bolman C, Candel MJ, Wiers RW, de Vries H. Preventing smoking relapse via Web-based computer-tailored feedback: a randomized controlled trial. *J Med Internet Res*. 2012 Aug 20;14(4):e109.
- [37]. Japuntich SJ, Zehner ME, Smith SS, Jorenby DE, Valdez JA, Fiore MC, Baker TB, Gustafson DH. Smoking cessation via the internet: a randomized clinical trial of an internet intervention as adjuvant treatment in a smoking cessation intervention. *Nicotine Tob Res*. 2006 Dec;8 Suppl 1:S59-67.
- [38]. An LC, Klatt C, Perry CL, Lein EB, Hennrikus DJ, Pallonen UE, Bliss RL, Lando HA, Farley DM, Ahluwalia JS, Ehlinger EP. The RealU online cessation intervention for college smokers: a randomized controlled trial. *Prev Med*. 2008 Aug;47(2):194-9. (name of author in text is mismatched, please use the sir name of author used in reference to text only)

- [39]. McDonnell DD, Kazinets G, Lee HJ, Moskowitz JM. An internet-based smoking cessation program for Korean Americans: results from a randomized controlled trial. *Nicotine Tob Res.* 2011 May;13(5):336-43.
- [40]. Oenema A, Brug J, Dijkstra A, de Weerdt I, de Vries H. Efficacy and use of an internet-delivered computer-tailored lifestyle intervention, targeting saturated fat intake, physical activity and smoking cessation: a randomized controlled trial. *Ann Behav Med.* 2008 Apr;35(2):125-35.
- [41]. Pisinger C, Jørgensen MM, Møller NE, Døssing M, Jørgensen T. A cluster randomized trial in general practice with referral to a group-based or an Internet-based smoking cessation programme. *J Public Health (Oxf).* 2010 Mar;32(1):62-70.
- [42]. Smit ES, de Vries H, Hoving C. Effectiveness of a Web-based multiple tailored smoking cessation program: a randomized controlled trial among Dutch adult smokers. *J Med Internet Res.* 2012 Jun 11;14(3):e82.
- [43]. Swartz LH, Noell JW, Schroeder SW, Ary DV. A randomised control study of a fully automated internet based smoking cessation programme. *Tob Control.* 2006 Feb;15(1):7-12.
- [44]. Pike KJ, Rabius V, McAlister A, Geiger A. American Cancer Society's QuitLink: randomized trial of Internet assistance. *Nicotine Tob Res.* 2007 Mar;9(3):415-20.
- [45]. Rabius V, Pike KJ, Wiatrek D, McAlister AL. Comparing internet assistance for smoking cessation: 13-month follow-up of a six-arm randomized controlled trial. *J Med Internet Res.* 2008 Nov 21;10(5):e45.
- [46]. Feil EG, Noell J, Lichtenstein E, Boles SM, McKay HG. Evaluation of an Internet-based smoking cessation program: lessons learned from a pilot study. *Nicotine Tob Res.* 2003 Apr;5(2):189-94.
- [47]. Eysenbach G. Issues in evaluating health websites in an Internet-based randomized controlled trial. *J Med Internet Res.* 2002 Dec;4(3):E17.
- [48]. Eysenbach G. The law of attrition. *J Med Internet Res.* 2005 Mar 31;7(1):e11.
- [49]. Civljak M, Sheikh A, Stead LF, Car J. Internet-based interventions for smoking cessation. *Cochrane Database Syst Rev.* 2010;8:CD007078. (Refence mismatch, pls check)
- [50]. McKay HG, Danaher BG, Seeley JR, Lichtenstein E, Gau JM. Comparing two web-based smoking cessation programs: randomized controlled trial. *J Med Internet Res.* 2008 Nov 18;10(5):e40.
- [51]. Rabius V, Pike KJ, Wiatrek D, McAlister AL. Comparing internet assistance for smoking cessation: 13-month follow-up of a six-arm randomized controlled trial. *J Med Internet Res.* 2008 Nov 21;10(5):e45.
- [52]. Stoddard JL, Augustson EM, Moser RP. Effect of adding a virtual community (bulletin board) to smokefree. gov: Randomized controlled trial. *J Med Internet Res.* 2008;10:e53.
- [53]. Etter JF. Comparing computer-tailored, internet-based smoking cessation counseling reports with generic, untailored reports: A randomized trial. *J Health Commun.* 2009;14:646-57.
- [54]. Muñoz RF, Lenert LL, Delucchi K, Stoddard J, Perez JE, Penilla C, et al. Toward evidence-based Internet interventions: A Spanish/English Web site for international smoking cessation trials. *Nicotine Tob Res.* 2006;8:77-87.
- [55]. Muñoz RF, Barrera AZ, Delucchi K, Penilla C, Torres LD, Pérez-Stable EJ. International Spanish/English Internet smoking cessation trial yields 20% abstinence rates at 1 year. *Nicotine Tob Res.* 2009;11:1025-34.
- [56]. Strecher VJ, McClure JB, Alexander GL, Chakraborty B, Nair VN, Konkel JM, et al. Web-based smoking-cessation programs: Results of a randomized trial. *Am J Prev Med.* 2008;34:373-81.
- [57]. Strecher VJ, Shiffman S, West R. Randomized controlled trial of a web-based computer-tailored smoking cessation program as a supplement to nicotine patch therapy. *Addiction.* 2005;100:682-8.
- [58]. Fox S. Pew Internet. Washington, DC: Pew Internet & American Life Project; 2006 Oct 29. Online health search 2006 URL: http://www.pewinternet.org/~media/Files/Reports/2006/PIP_Online_Health_2006.pdf [accessed 2010-06-25] [WebCite Cache]
- [59]. Meenan, R. T., Stevens, V. J., Funk, K., Bauck, A., Jerome, G. J., Lien, L. F., et al. Development

and implementation cost analysis of telephone- and internet-based interventions for the maintenance of weight loss. *International Journal of interventions. Annals of Behavioral Medicine*. 2009; 38:18–27.

- [60]. Bloom EL, Minami H, Brown RA, Strong DR, Riebe D, Abrantes AM. Quality of life after quitting smoking and initiating aerobic exercise. *Psychol Health Med*. 2017 Oct;22(9):1127-1135.

Figures

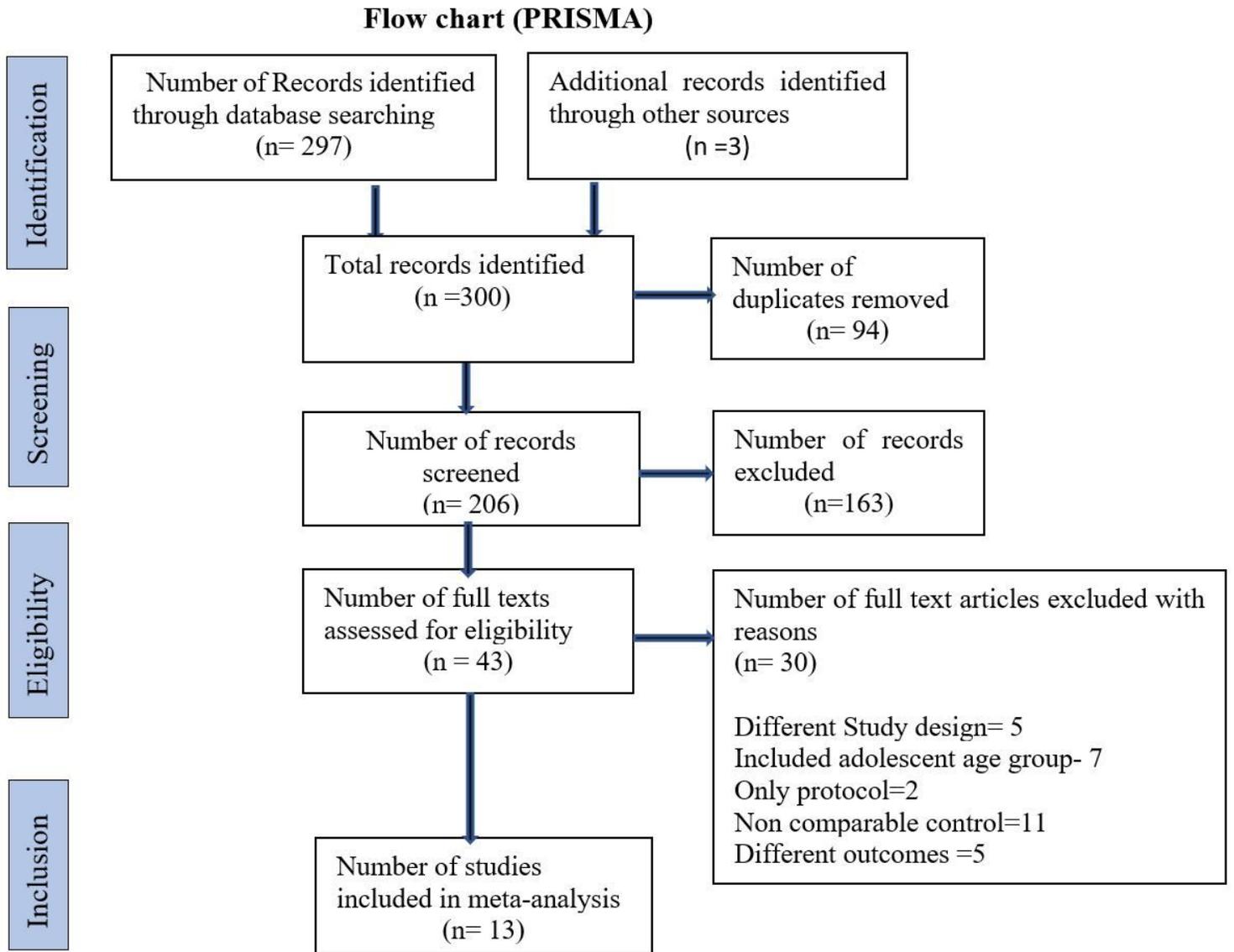


Figure 1

Flow chart (PRISMA)

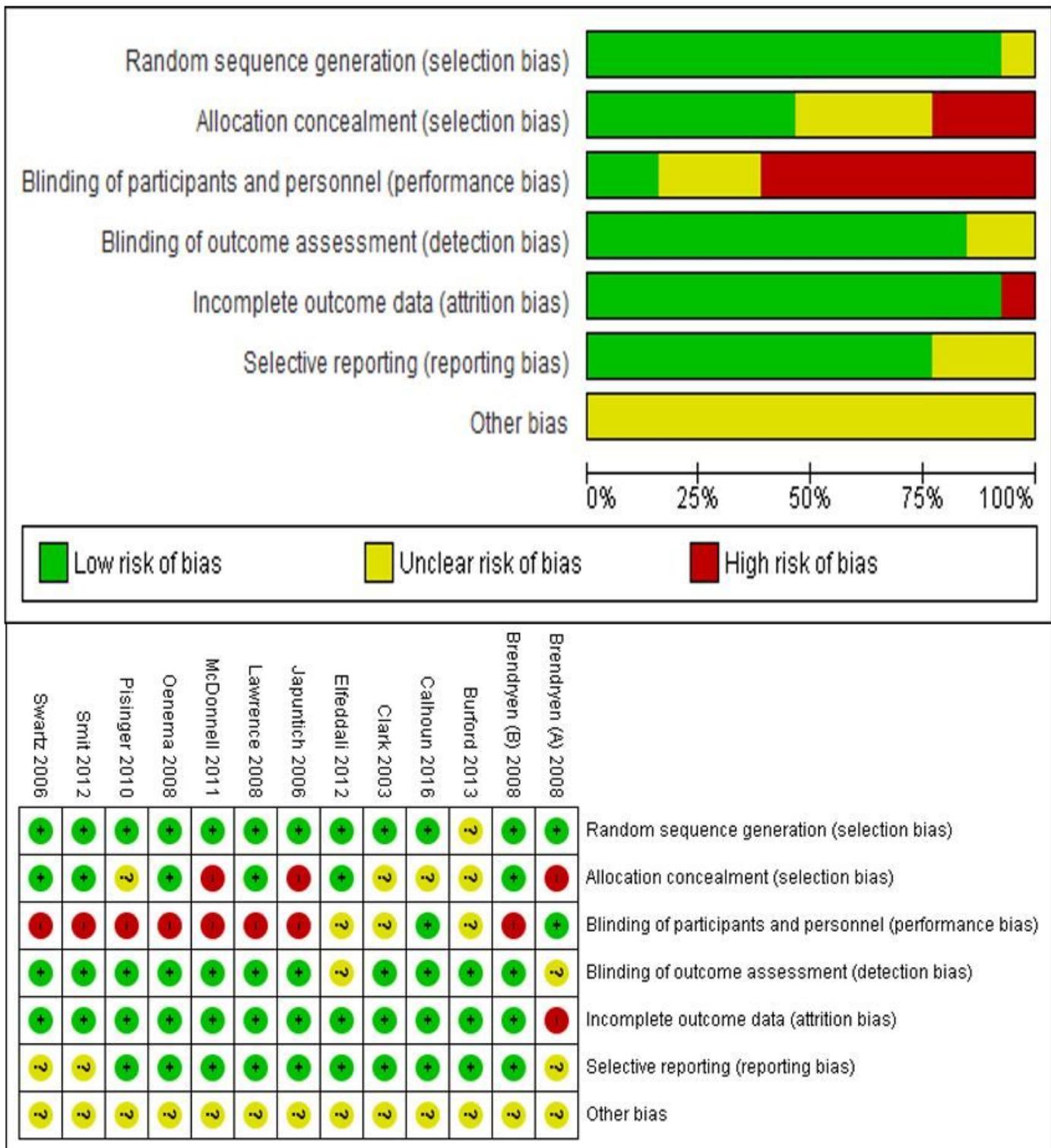
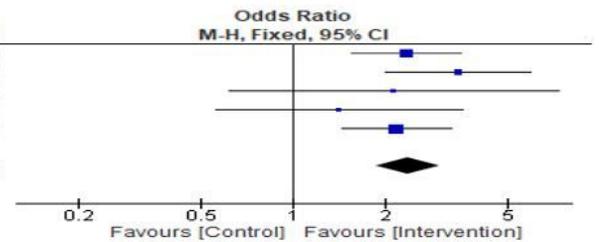


Figure 2

Risk of bias graph and summary

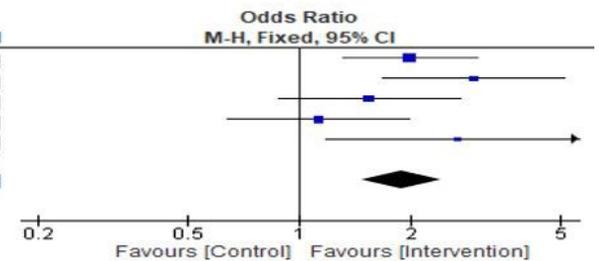
Tobacco quit at 1 month follow up

Study or Subgroup	Intervention		Control		Weight	Odds Ratio M-H, Fixed, 95% CI
	Events	Total	Events	Total		
Brendryen (A) 2008	99	200	59	200	33.9%	2.34 [1.55, 3.53]
Brendryen (B) 2008	60	144	25	146	16.5%	3.46 [2.01, 5.95]
Clark 2003	8	85	4	86	4.1%	2.13 [0.62, 7.36]
Oenema 2008	11	272	8	275	8.7%	1.41 [0.56, 3.55]
Smit 2012	74	552	38	571	36.8%	2.17 [1.44, 3.27]
Total (95% CI)		1253		1278	100.0%	2.37 [1.86, 3.02]
Total events	252		134			
Heterogeneity: $\text{Chi}^2 = 3.28$, $\text{df} = 4$ ($P = 0.51$); $I^2 = 0\%$						
Test for overall effect: $Z = 7.01$ ($P < 0.00001$)						



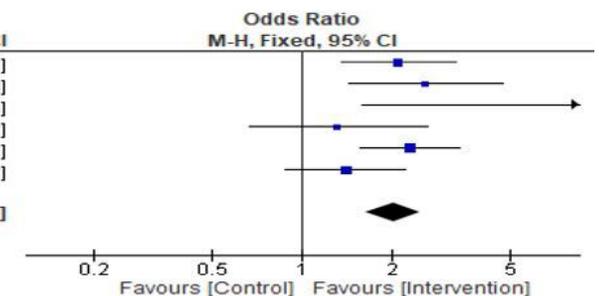
Tobacco quit at 3 months follow up

Study or Subgroup	Intervention		Control		Weight	Odds Ratio M-H, Fixed, 95% CI
	Events	Total	Events	Total		
Brendryen (A) 2008	88	200	57	200	32.8%	1.97 [1.30, 2.99]
Brendryen (B) 2008	51	144	23	146	15.2%	2.93 [1.67, 5.14]
Calhoun 2016	35	205	24	203	20.6%	1.54 [0.88, 2.69]
Japuntich 2006	32	140	30	144	23.5%	1.13 [0.64, 1.98]
Swartz 2006	21	171	9	180	7.9%	2.66 [1.18, 5.99]
Total (95% CI)		860		873	100.0%	1.88 [1.48, 2.40]
Total events	227		143			
Heterogeneity: $\text{Chi}^2 = 6.85$, $\text{df} = 4$ ($P = 0.14$); $I^2 = 42\%$						
Test for overall effect: $Z = 5.14$ ($P < 0.00001$)						



Tobacco quit at 6 months follow up

Study or Subgroup	Intervention		Control		Weight	Odds Ratio M-H, Fixed, 95% CI
	Events	Total	Events	Total		
Brendryen (A) 2008	73	200	43	200	22.3%	2.10 [1.35, 3.27]
Brendryen (B) 2008	42	144	20	146	11.5%	2.59 [1.43, 4.69]
Burford 2013	11	80	1	80	0.7%	12.59 [1.59, 100.05]
Japuntich 2006	21	140	17	144	11.6%	1.32 [0.66, 2.62]
Lawrence 2008	105	257	60	260	28.8%	2.30 [1.57, 3.37]
Smit 2012	45	552	34	571	25.1%	1.40 [0.88, 2.22]
Total (95% CI)		1373		1401	100.0%	2.02 [1.64, 2.50]
Total events	297		175			
Heterogeneity: $\text{Chi}^2 = 8.06$, $\text{df} = 5$ ($P = 0.15$); $I^2 = 38\%$						
Test for overall effect: $Z = 6.52$ ($P < 0.00001$)						



Tobacco quit at one year follow up

Study or Subgroup	Intervention		Control		Weight	Odds Ratio M-H, Fixed, 95% CI
	Events	Total	Events	Total		
Brendryen (A) 2008	74	200	48	199	17.6%	1.85 [1.20, 2.85]
Brendryen (B) 2008	47	144	33	146	12.8%	1.66 [0.99, 2.79]
Clark 2003	4	85	9	86	4.9%	0.42 [0.12, 1.43]
Elfeddali 2012	63	190	45	202	16.9%	1.73 [1.11, 2.71]
McDonnell 2011	102	272	100	315	33.6%	1.29 [0.92, 1.81]
Pisinger 2010	28	476	25	442	14.2%	1.04 [0.60, 1.82]
Total (95% CI)		1367		1390	100.0%	1.43 [1.18, 1.74]
Total events	318		260			
Heterogeneity: $\text{Chi}^2 = 7.79$, $\text{df} = 5$ ($P = 0.17$); $I^2 = 36\%$						
Test for overall effect: $Z = 3.64$ ($P = 0.0003$)						

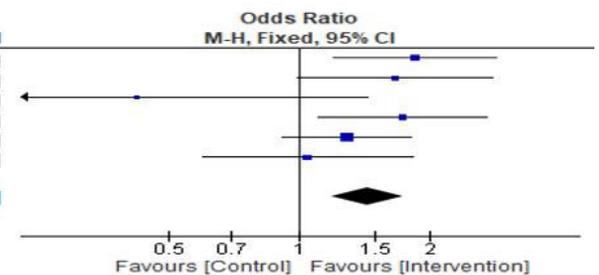


Figure 3

Forest plot comparing internet intervention with the control group

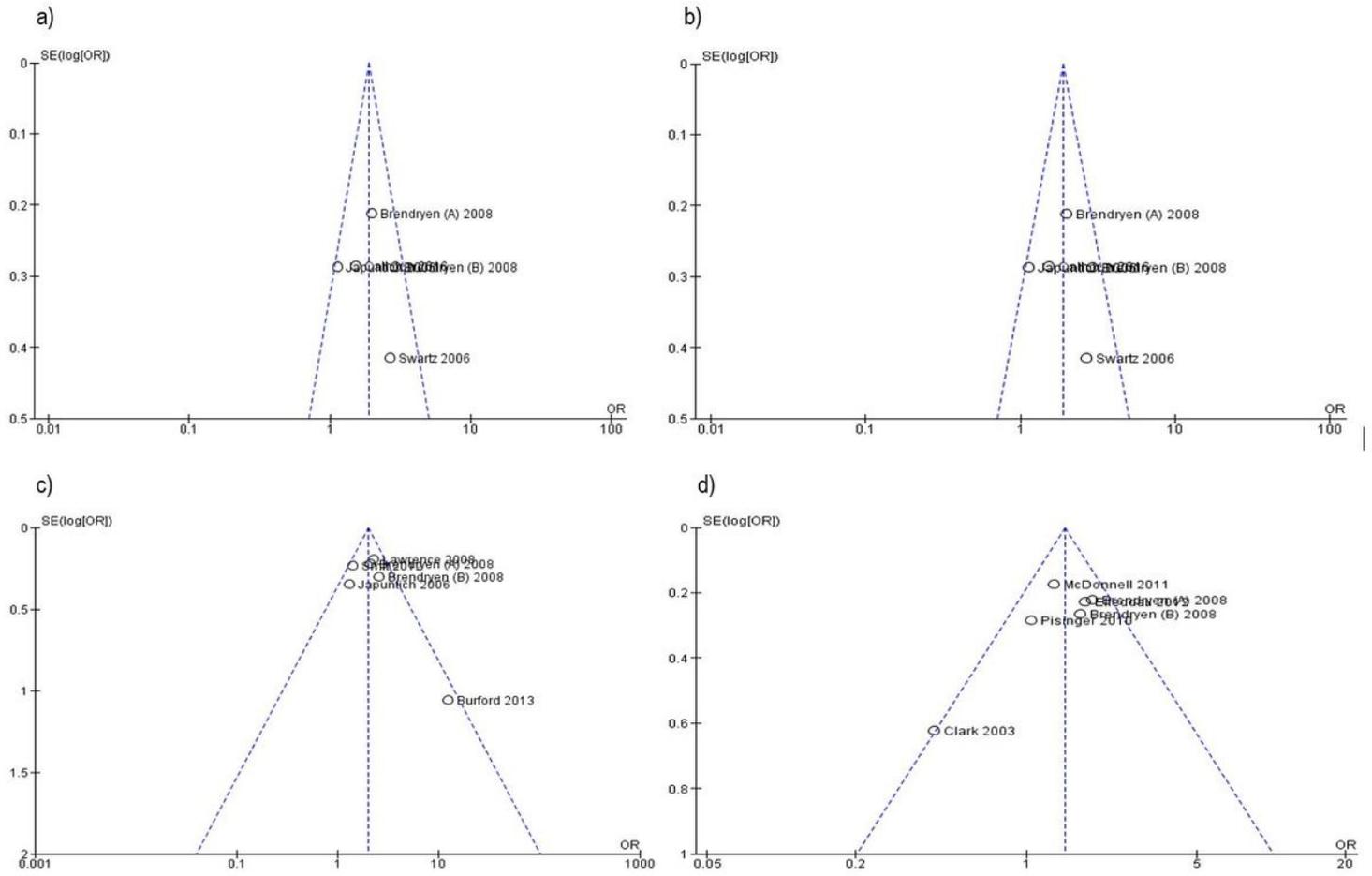


Figure 4

Funnel plot: shows publication bias across studies for each outcome a) Tobacco quitting at one month b) Tobacco quitting at three months c) Tobacco quitting at six months d) Tobacco quitting at one year