



The effect and cost-effectiveness of mass media campaigns on health behaviour change: A narrative systematic review

July 2022

Together we will beat cancer



Reference

This report should be referred to as follows:

Behavioural Science and Evaluation Team, Cancer Research UK. The effect and cost-effectiveness of mass media campaigns on health behaviour change: A narrative systematic review. Published July 2022.

Authors

Maya Kamar, Kirstie Osborne, and Victoria Whitelock

Acknowledgements

The authors wish to acknowledge the contribution of Fiona Osgun in supporting with the study search stage of this review.

Cancer Research UK

Cancer Research UK is the world's largest independent cancer charity dedicated to saving lives through research. We support research into all aspects of cancer through the work of over 4,000 scientists, doctors and nurses. In 2017/2018, we spent £423 million on research institutes, hospitals and universities across the UK. We receive no funding from Government for our research.



Cancer Research UK is a registered charity in England and Wales (1089464), Scotland (SC041666) and the Isle of Man (1103)

<http://www.cancerresearchuk.org/>

Executive summary

Background

Mass media campaigns (MMCs) can reach a large number of people with health messages, but it is unclear how effective these are at changing health behaviours. This review aimed to examine the impact of MMCs on eight health behaviours, as well as their cost-effectiveness.

Methods

We conducted a narrative systematic review of systematic reviews on the effect of MMCs on tobacco use, dietary behaviours, alcohol use, physical activity, sun and UV-protection, HPV vaccination, cancer screening uptake, and symptomatic GP presentation. We searched EMBASE, PubMed, Medline, and Web of Science for systematic reviews published after 2000 and used the Risk of Bias in Systematic reviews (ROBIS) tool to assess the quality of included reviews. We also conducted a rapid review of the cost effectiveness of MMCs.

Results

A total of 56 reviews met the inclusion criteria. MMCs had a strong positive impact on dietary behaviours and cancer screening uptake, moderate positive impact on sun and UV protection behaviours, and a weak positive impact on HPV vaccination uptake. There was strong but mixed evidence for the effectiveness of MMCs on tobacco use, and moderate mixed evidence for physical activity. There was insufficient evidence for alcohol use and symptomatic GP presentation. MMCs were more likely to be effective when part of multi-component, community-based interventions, and when targeting infrequent than frequent health behaviours. There were a limited number of reviews examining cost-effectiveness, and the evidence was mixed.

Conclusions

MMCs should be used as part of multi-component, community-based interventions (that also include service provision, altered environments, fiscal measures and policy measures). More research is needed to assess the cost-effectiveness of MMCs.

Contents

REFERENCE	2
AUTHORS	2
ACKNOWLEDGEMENTS	2
CANCER RESEARCH UK.....	2
EXECUTIVE SUMMARY	3
BACKGROUND	3
METHODS	3
RESULTS	3
CONCLUSIONS.....	3
CONTENTS.....	4
LIST OF ACRONYMS.....	5
INTRODUCTION.....	6
BACKGROUND	6
STUDY AIMS	7
METHODS	8
RESULTS	10
EFFECTIVENESS ON HEALTH BEHAVIOUR CHANGE	10
CANCER PREVENTION BEHAVIOURS	10
CANCER SCREENING UPTAKE	12
SYMPTOMATIC GP PRESENTATION	12
COST EFFECTIVENESS OF MMCS	22
DISCUSSION	25
CONCLUSION	26
APPENDIX.....	27
REFERENCES.....	29

List of acronyms

MMC: Mass Media Campaign

Introduction

Background

Cancer is the leading cause of mortality in the world,[1] and around 367,000 new cancer cases are diagnosed in the UK every year – nearly 1,000 every day in 2015-2017.[2] However, around 4 in 10 cancers can be prevented via modifiable lifestyle factors such as not smoking, keeping a healthy weight, and reducing sun and UV exposure.[3] Cancer screening programmes can also reduce the risk of developing some cancers[4] and diagnosis of cancer at an earlier stage, such as via screening programmes or GP presentation, is associated with higher cancer survival.[5-8] Mass media, which involves passive message dissemination through platforms like radio, television, billboards and, more recently, digital, and social media, has been used by governments and organisations for reaching large numbers of people with behaviour change messages.[9, 10] Mass media campaigns (MMCs) have been used to target health behaviours, most notably tobacco use[11] and physical activity,[12] but also diet, alcohol use, cancer screening uptake, and other public health topics.[13, 14]

MMCs exert their impact on behaviour either directly by prompting and supporting action or indirectly by influencing the environment, which may in turn lead to behaviour change.[13] For example, a stop-smoking campaign may emphasise the benefits of quitting and the risks of smoking as well as provide a support helpline or signpost to local stop-smoking services, tips on stop-smoking tools and how to obtain them. MMCs which influence behaviour indirectly may do so by creating discussion on the topic, influencing social and cultural norms, and creating policy support.

There are advantages and disadvantages to using mass media to promote health behaviour change. MMCs can send focused, repeated, engaging messages, reaching a large number of people at a low cost per head. However, MMCs may not reach or engage particular groups due to their often generic messages, producing different responses across groups or unintended consequences. It may also not be possible to provide the resources or tools required to initiate and sustain behaviour change, particularly in disadvantaged social groups.[10] This risks widening existing health inequalities, with previous reviews having found that untargeted mass media campaigns are likely to have widened existing inequalities, despite positive effects on behaviour change.[15]

Two recent reviews have been conducted on the effectiveness of MMCs on cancer prevention, early diagnosis and screening behaviours. Wakefield et al.[13] comprehensively reviewed, up to year 2009, most cancer prevention, early diagnosis and screening related behaviours, in addition to other health topics. A more recent review was conducted in by Stead et al.[10] (search carried out in year 2016), but this only reviewed tobacco use, alcohol use, diet, and physical activity. Evidence from both reviews was generally mixed on these health behaviours, due to study heterogeneity and limited evaluation for some health behaviours. Research on MMCs targeting tobacco use provided the largest literature, with results showing promising yet mixed effects of MMCs on behaviour change.[10] Wakefield et al.[13] cited factors which contributed to positive outcomes, which included the availability of

required services and products, availability of community-based programmes, and policies that support behaviour change.[13] Stead et al.[10] cited longer duration or greater intensity of campaigns as an effective component of MMCs. Strong positive or negative targeted messages, and social norming messages also had a greater impact on behaviour change.

Study aims

The present review aimed to provide an update on evidence since the reviews by Wakefield et al.[13] and Stead et al.[10] Specifically, we included research published since the review by Wakefield et al.,[13] and review a wider range of health behaviours relevant to cancer than reviewed by Stead et al.[10] We conducted a systematic review of systematic reviews of the effect of MMCs on cancer prevention behaviours, cancer screening uptake and symptomatic GP presentation. The specific behaviours of interest were: (I) cancer prevention behaviours (tobacco use, dietary behaviours, alcohol use, physical activity, sun and UV-protection and HPV vaccination), (II) cancer screening uptake and (III) symptomatic presentation to GP. We also conducted a rapid review of the cost-effectiveness of MMCs.

CONTRIBUTIONS TO THE LITERATURE

- The review provides an update on evidence since the reviews by Wakefield et al. [13] and Stead et al. [10] on the impact of mass media campaigns (MMCs) on health behaviour change. We focus on cancer prevention behaviours, cancer screening and early diagnosis, as well as cost-effectiveness of the campaigns.
- MMCs should be used as part of multi-component, community-based interventions (that also include service provision, altered environments, fiscal measures and policy measures). MMCs may be more effective at encouraging changes in infrequent behaviours such as cancer screening.
- More research is needed to assess the cost-effectiveness of MMCs.

Methods

The methods outlined below apply to the main systematic review and the rapid review on cost-effectiveness of MMCs, except where stated.

We searched EMBASE, PubMed, Medline, and Web of Science for systematic reviews¹ published after 2000, that were in English, full-text, and targeted any human population (for list of search terms see **Appendix**). Reviews had to include a minimum of one intervention that met our definition of a MMC: the intentional use of any media channel(s) of communication by local, regional and national organisations to influence lifestyle behaviour through largely passive or incidental exposure to media campaigns, rather than largely dependent on active help-seeking (adapted from Stead et al.[10]). This excludes, for example, health campaign websites that individuals actively searched for or signed up to. Reviews also had to examine one or more of the following health behaviours: tobacco use, dietary behaviours, alcohol use, physical activity, sun and UV-protection, HPV vaccination, cancer screening uptake, and symptomatic GP presentation. Finally, reviews had to report outcome data related to behaviour change rather than just determinants of behaviour (such as intentions) and, when describing multi-component interventions,² had to report outcomes in relation to the mass media component.

Search results were pooled and screened based on abstract and title by two reviewers, then full texts were screened, and conflicts were resolved by consensus. References of included reviews were checked to identify any further reviews. See **Figure 1** for the PRISMA flow chart[16] outlining the screening and selection process for the main review and rapid review. We extracted data on behavioural outcomes assessed, the number of studies within reviews reporting on MMCs (marked as '*relevant*' in **Tables 1 and 2**), intervention details such as whether they were multi-component or community-based³, results as reported by review authors, and components which supported in quality assessment of reviews (which was only conducted in the main review on behaviour change). We also looked for patterns in the results to identify characteristics of MMCs that tended to have positive effects on the target behaviour e.g. whether the MMCs were community-based, multi-component interventions etc. We also extracted cost-effectiveness results as reported by review authors for the rapid review of the cost effectiveness of MMCs. Heterogeneity of comparisons, outcomes, and

¹ According to Stead et al.,¹⁰ systematic reviews were defined as "including a specified search strategy from more than one database, an assessment of the quality of studies and some kind of synthesis of the primary studies."

² Multi-component interventions refer to interventions which include mass media as well as non-mass media components, such as support and various intervention activities.

³ According to Secker-Walker et al.,[17] a community intervention is defined as "a co-ordinated, multi-dimensional programme aimed at changing [adult behaviour], involving several segments of the community and conducted in a defined geographical area, such as a town, city, country, or other administrative district" Examples may be community pharmacy-based interventions, group-based counselling, incentive-based contests within a community, or mass media campaigns directed at certain communities within a defined geographical area

study design of the included reviews precluded meta-analysis. A narrative synthesis was conducted and the results are presented in **Tables 1** and **2**. We describe the direction and strength of evidence of the effect of MMCs on health behaviour change as positive, negative, mixed, or insufficient evidence. Positive indicates that the evidence had the intended effect on the specified health behaviour from a public health perspective (e.g. increased smoking quit attempts, reduced alcohol consumption). Negative means that the evidence had the opposite of the intended effect on the specified health behaviour (e.g. smoking increased or alcohol consumption increased). Mixed effects mean some evidence found positive, negative and no effects on behaviour. Insufficient evidence means there was not enough evidence to draw conclusions due to the small number of relevant studies within the reviews, or when stated as such by the authors. We used the Risk of Bias in Systematic reviews (ROBIS)[18] tool to assess the quality of included reviews for the main research question, but not for the rapid review on cost-effectiveness of MMCs. This was carried out by one author, and 10% of the results were cross-checked by another author.

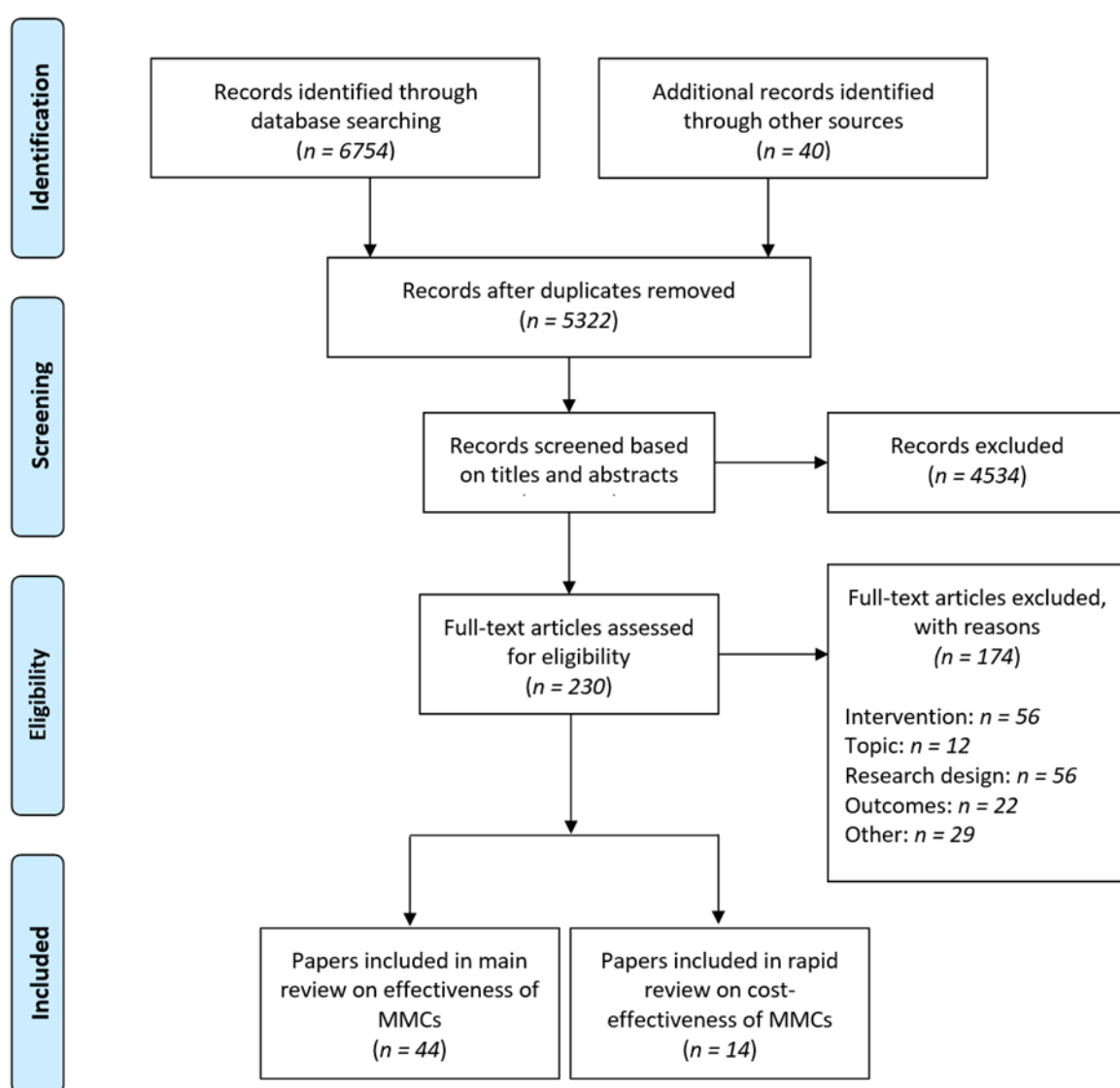


Figure 1. PRISMA flowchart outlining the process of review screening and selection for the main review and rapid review

Results

A total of 56 reviews met the inclusion criteria: 44 for the main review on effectiveness of MMCs on health behaviour change, and 14 reviews on cost-effectiveness of MMCs (see **Figure 1**). Two reviews were included in both the main and rapid review, since they examined both effectiveness and cost-effectiveness of MMCs. Findings for the effectiveness of MMCs on health behaviours, are presented by health behaviour (see **Table 1**). This is followed by results of the rapid review on cost-effectiveness (see **Table 2**).

Effectiveness on health behaviour change

Cancer Prevention Behaviours

Tobacco Use

The largest number of reviews across all examined behaviours were on tobacco use (19 reviews). These reviews included outcomes on prevention of smoking uptake[19-27] and smoking cessation.[11, 15, 20, 24, 26-33] Eleven reviews were considered to have low risk of bias,[11, 20, 23-26, 29-31, 33, 34] and eight reviews were considered to have high risk of bias.[15, 19, 21, 22, 27, 28, 32, 35] Eleven reviews reported mixed or insufficient evidence of the impact of MMCs on smoking behaviour.[15, 19-22, 26, 28, 30-33] Eight reviews found a positive impact of MMCs on tobacco use.[11, 23-25, 27, 29, 34, 35] Overall, evidence for the impact of MMCs was strong but mixed.

In most reviews on tobacco use, positive results were seen when MMCs were part of multi-component, community-based interventions.[11, 15, 21, 24, 25, 29, 31-35] These often involved provision of support, affordable alternatives or products, fiscal measures, or availability of local stop-smoking services. Interventions benefitted from having a clearly-stated behavioural theoretical basis, targeted messaging, and using formative research⁴ to design the campaign messages.[19, 23, 27, 30, 34, 35] Campaigns tended to be more successful when they had longer durations, higher intensity and repetitiveness of messaging, and where multiple types of media were used.[11, 19, 23, 25, 33-35]

Diet

Five reviews examined the impact of mass media on improved diet, with outcomes being: increased vegetable and fruit consumption, and reduced red/processed meat, high-fat/sugar food, and salt intake.[26, 34, 36-38] Most of these reviews observed multiple health behaviours and included studies of multicomponent interventions. Four reviews were

⁴ Formative research comprises of using qualitative and/or quantitative methods to provide information for researchers to inform planning intervention programmes. This may include understanding the target population, environmental and personal factors, as well as the key barriers and facilitators to behaviour change.

considered to have low risk of bias, and one of the reviews was considered to have a high risk of bias.[38] There was positive evidence for the effects of MMCs on dietary intake in four of the reviews,[34, 36, 38, 39] with the remaining one reporting positive impact only on determinants of healthy eating such as knowledge and awareness, and not on dietary intake.[26] Overall, there was strong positive evidence for the effects of MMCs on diet.

Most positive results were seen when MMCs were part of multi-component, community-based interventions.[34, 36, 38, 39] Campaigns tended to be more successful when they used targeted messaging, had longer durations, higher intensity and repetitive messaging, and where multiple types of media were used.[34, 38] Some campaigns achieving positive results also promoted specific healthy food choices, in addition to providing prompts at the point of decision making – known as behavioural nudges.[34, 36, 39] One of the reviews looked into “stop” or “go” behaviours, such as not eating fast food vs. increasing the consumption of fruits and vegetables respectively, and found that campaigns with both “stop” and “go” outcomes (such as swapping) tended to be the most successful in changing eating behaviour.[38]

Alcohol use

Three reviews examined the impact of MMCs on reducing alcohol consumption and misuse.[40-42] Two of the reviews were considered to have low risk of bias,[40, 42] and one review had a high risk of bias.[41] All reviews reported insufficient evidence to draw conclusions on the effectiveness of MMCs to change alcohol use. This was due to the small number of studies on MMCs and weak quality of included evidence, as reported by review authors. Moreover, most studies in the literature reported on determinants of behavioural outcomes, such as knowledge, attitudes and treatment seeking (and not alcohol consumption rates),[40] or the impact of policy-related strategies such as availability and fiscal measures (without MMCs).[41] Overall, there was strong but insufficient evidence for the effect of MMCs on alcohol use.

Physical activity

Nine reviews assessed the impact of MMCs on physical activity. A range of outcomes were examined, including overall physical activity, walking, and using the stairs. Five reviews were considered to have low risk of bias,[12, 34, 36, 43, 44] and four were considered to have high risk of bias.[45-48] Five reviews reported mixed or insufficient evidence[12, 45-48] and four reviews found a positive impact of MMCs on physical activity.[34, 36, 43, 44] Overall, the evidence was of moderate strength but mixed.

Across reviews, campaigns finding a positive impact on behaviour change were mostly among motivated individuals, part of multi-component interventions, included changes in the environment, and provided prompts at the point of decision making.[34, 36, 44, 46, 48] Further, positive impacts on behaviour were found in studies that used social norming to promote physical activity,[43] as well as targeted messages and use of multiple types of media.[34] Some reviews found that MMCs were effective in promoting walking[43, 44] but

did not decrease overall sedentary behaviour.[43]

Sun and UV-protection

Two reviews examined the impact of mass media on sun and UV-protection behaviours.[49, 50] The behavioural outcomes in these reviews were wearing sunscreen, avoiding sun exposure, covering skin with clothing/hats, as well as reduced UV exposure through reduced use of indoor tanning. One of the reviews was considered to have a low risk of bias[50] and the other review was considered to have a high risk of bias.[49] There was weak evidence for mass media alone, due to the low number of studies assessing MMCs in isolation. However, both reviews reported overall moderate positive effects on sun and UV-protection behaviours when MMCs were part of multi-component, community-based interventions.

HPV vaccination

Two reviews examined the impact of MMCs on HPV vaccination uptake.[51, 52] Both reviews were considered to have a high risk of bias. Overall, there was weak but positive evidence for HPV vaccination, given the reported results, and the fact that both reviews looked into the same two successful campaigns and reported similar findings. These campaigns were part of multi-component, community-based interventions and involved social marketing with targeted messages and patient reminders.[51, 52]

Cancer screening uptake

Eight reviews examined the impact of MMCs on cancer screening uptake. The largest number of reviews focused on breast,[53-57] cervical,[53-58] and bowel cancer screening.[53-55, 57, 59] Very few reviews looked into other cancer types, such as: oral[53], prostate[54], and testicular[60]. Five of the reviews were considered to have low risk of bias[53, 55, 57, 58, 60] and three reviews were considered to have high risk of bias.[54, 56, 59] Five reviews found positive evidence for MMCs on cancer screening uptake[54, 56, 58-60] and three reviews found mixed or insufficient evidence.[53, 55, 57] Overall, there was strong positive evidence of the effect of MMCs on screening uptake.

Across all cancer types, the positive evidence was primarily in multi-component interventions which targeted messages and multiple types of media.[54, 56, 58-60] Positive results were particularly evident during the campaign period, and when campaigns were combined with education, reminders, and easy access to screening services. Community-based interventions which were culturally-adapted were also particularly successful in changing behaviour.[54]

Symptomatic GP presentation

No reviews on symptomatic GP presentation met the review inclusion criteria.

Table 1 . Summary of reviews of MMC features and effectiveness on behaviour change, by health behaviour

Behaviour	Review details	Relevant behavioural outcomes measured	Total studies in review and number of relevant* studies	Risk of Bias	Summary results
Tobacco use	Bala et al., 2017 [11]	Smoking cessation	11 total - 11 relevant studies	<i>Low risk of bias</i>	<i>Strong mixed evidence for benefit</i>
	Carson-Chahhoud et al., 2017 [19]	Prevention of smoking uptake	8 total - 8 relevant studies	<i>High risk of bias</i>	
	Chamberlain et al., 2017 [20]	Prevention of smoking uptake	21 total – 11 relevant studies	<i>Low risk of bias</i>	
	Mosdøl et al., 2017 [28]	Smoking cessation	6 total - 6 relevant studies	<i>High risk of bias</i>	
	Multiple behaviour: tobacco use				
	de Kleijn et al., 2015 [21]	Prevention of smoking uptake	37 total – 4 relevant studies Mass media not the sole focus	<i>High risk of bias</i>	
	Robinson et al., 2014	Smoking	22 total – 3 relevant studies	<i>Low risk of</i>	

	[29] Multiple behaviour: tobacco use	cessation	Mass media sole focus	<i>bias</i>	
	Brown et al. 2014a [22]	Prevention of smoking uptake	38 total – 1 relevant study Mass media not the sole focus	<i>High risk of bias</i>	
	Brown et al., 2014b [15]	Smoking cessation	117 total – 18 relevant studies Mass media not the sole focus	<i>High risk of bias</i>	
	Gould et al., 2013 [30]	Smoking cessation	20 total – 11 relevant studies Mass media not the sole focus	<i>Low risk of bias</i>	
	Brinn et al., 2012 [23]	Prevention of smoking uptake	7 relevant studies Mass media sole focus	<i>Low risk of bias</i>	
	Guillaumier et al., 2012 [31]	Smoking cessation	17 relevant studies Mass media sole focus	<i>Low risk of bias</i>	
	(Mozaffarian et al., 2012 [34]	Smoking cessation +	100 total – 31 relevant studies	<i>Low risk of bias</i>	

	Multiple behaviour: diet, smoking and physical activity	Prevention of smoking uptake	Mass media not sole focus		
	Wilson et al., 2012 [24]	Smoking cessation + Prevention of smoking uptake	88 total – 19 relevant studies Mass media not the sole focus	<i>Low risk of bias</i>	
	Hemsing et al., 2011 [32]	Smoking cessation	9 total – 1 relevant study Mass media not the sole focus	<i>High risk of bias</i>	
	Jepson et al., 2007 [33]	Smoking cessation	44 total – 39 relevant studies Mass media sole focus	<i>Low risk of bias</i>	
	Richardson et al., 2007 [25]	Prevention of smoking uptake	41 total – 37 relevant studies	<i>Low risk of bias</i>	
	Byrne et al., 2005 [35] Multiple behaviour: tobacco use	Prevention of smoking uptake	25 total – 12 relevant studies Mass media sole focus	<i>High risk of bias</i>	

	Ellis et al., 2003 [26] Multiple behaviour: diet, tobacco use	Smoking cessation + Prevention of smoking uptake	31 total – 8 relevant studies Mass media not sole focus	<i>Low risk of bias</i>	
	Derzon & Lipsey, 2002 [27] Multiple behaviour: tobacco use	Smoking cessation + Prevention of smoking uptake	72 relevant studies Mass media sole focus	<i>High risk of bias</i>	
Diet	Abril et al., 2019 [38]	Consumption of healthy food	14 total – 14 relevant studies Mass media sole focus	<i>High risk of bias</i>	<i>Strong positive evidence for benefit</i>
	Mozaffarian et al., 2012 [34] Multiple behaviour: diet, tobacco use and physical activity	Consumption of healthy food	100 total – 25 relevant studies Mass media not sole focus	<i>Low risk of bias</i>	
	Matson-Koffman et al., 2005 [36] Multiple behaviour:	Consumption of healthy food	64 total - 6 relevant studies Mass media not the sole focus	<i>Low risk of bias</i>	

	Diet and physical activity				
	Pomerleau et al., 2005 [37]	Fruit and vegetable intake	44 total – 8 relevant studies Mass media not sole focus	<i>Low risk of bias</i>	
	Ellis et al., 2003 [26] Multiple behaviour: Diet and tobacco use	Consumption of healthy food	31 total – 8 relevant Mass media not sole focus	<i>Low risk of bias</i>	
Alcohol use	Young et al., 2018 [40]	Alcohol consumption	24 relevant studies Mass media sole focus	<i>Low risk of bias</i>	<i>Insufficient evidence for benefit</i>
	Anderson et al., 2009 [41]	Alcohol consumption	17 relevant studies Mass media not sole focus	<i>High risk of bias</i>	
	Moreira et al., 2009 [42]	Alcohol consumption	22 total – 2 relevant studies Mass media not sole focus	<i>Low risk of bias</i>	
Physical activity	Thomas et al., 2018 [12]	Overall physical activity	8 relevant studies Mass media sole focus	<i>Low risk of bias</i>	<i>Moderate mixed evidence for benefit</i>

	Abioye et al., 2013 [43]	Overall physical activity	9 relevant studies Mass media sole focus	<i>Low risk of bias</i>	
	Brown et al., 2012 [45]	Time spent in physical activity	16 relevant studies Mass media sole focus	<i>High risk of bias</i>	
	Mozaffarian et al., 2012 [34] Multiple behaviour: diet, tobacco use and physical activity	Overall physical activity	100 total – 25 relevant studies Mass media not sole focus	<i>Low risk of bias</i>	
	Leavy et al., 2011 [48]	Overall physical activity	18 relevant studies Mass media sole focus	<i>High risk of bias</i>	
	Ogilvie et al., 2007 [44]	Walking behaviour	48 total – 2 relevant studies Mass media not sole focus	<i>Low risk of bias</i>	
	Finlay & Faulkner, 2005 [47]	Overall physical activity	17 total – 8 relevant studies Mass media sole focus	<i>High risk of bias</i>	
	Matson-Koffman et al.,	Stair use	64 total – 5 relevant studies	<i>Low risk of</i>	

	2005 [36] Multiple behaviour: Diet and physical activity		Mass media not sole focus	<i>bias</i>	
	Kahn et al., 2002 [46]	Stair use	94 total – 6 relevant studies Mass media not sole focus	<i>High risk of bias</i>	
Sun and UV-protection behaviours	Sandhu et al., 2016 [50]	Sun/UV-protection behaviours	7 total – 4 relevant Mass media not sole focus	<i>Low risk of bias</i>	<i>Moderate positive evidence for benefit</i>
	Saraiya et al., 2004 [49]	Sun/UV-protection behaviours	3 relevant studies Mass media not sole focus	<i>High risk of bias</i>	
Vaccination/HPV vaccination	Smulian et al., 2016 [51]	HPV vaccination rate	34 total – 2 relevant studies	<i>High risk of bias</i>	<i>Weak positive evidence for benefit</i>
	Niccolai & Hansen, 2015 [52]	HPV vaccination rate	14 total – 2 relevant studies Mass media not sole focus	<i>High risk of bias</i>	
Cancer screening uptake	Schliemann et al., 2019 [53] Cancer type: Breast,	Screening uptake	22 total – 2 relevant studies Mass media not the sole focus	<i>Low risk of bias</i>	<i>Strong positive evidence for benefit</i>

	cervical, bowel, oral				
	Adedoyin et al., 2016 [54] Cancer type: Breast, cervical, bowel, prostate	Screening uptake	41 total – 16 relevant studies Mass media not sole focus	<i>High risk of bias</i>	
	Saab et al., 2016 [60] Cancer type: Testicular	Screening uptake	11 total – 1 relevant study Mass media, not sole focus	<i>Low risk of bias</i>	
	Brouwers et al., 2011 [57] Cancer type: Breast, cervical, bowel	Screening uptake	22 studies Mass media sole focus	<i>Low risk of bias</i>	
	Baron et al., 2008 [55] Cancer type: Breast, cervical, bowel	Screening uptake	3 relevant studies Mass media not sole focus	<i>Low risk of bias</i>	

	Black et al., 2002 [58] Cancer type: Cervical	Screening uptake	10 total - 4 relevant studies Mass media not sole focus	<i>Low risk of bias</i>	
	Snyder et al., 2004 [56] Cancer type: Breast, cervical	Screening uptake	4 relevant studies Mass media not sole focus	<i>High risk of bias</i>	
	Martini et al., 2016 [59] Cancer type: Bowel	Screening uptake	18 total – 4 relevant studies Mass media not sole focus	<i>High risk of bias</i>	
* relevance relates to the study's focus on MMCs and the behavioural outcomes of interest					

Cost effectiveness of MMCs

There were a limited number of reviews examining the cost-effectiveness of mass media activity on health behaviours – a total of 14 reviews. MMCs were not the sole focus of many of the included reviews. Reviews on cost-effectiveness mostly comprised economic evaluations and are listed in **Table 2**.

Nine reviews found that MMCs on tobacco use can be cost-effective.[11, 23, 61-67] Four reviews examined the cost-effectiveness of MMCs for physical activity and diet. There was positive evidence for physical activity[68, 69] and diet,[70, 71] mainly focusing on salt intake reduction. One review[68] examined evidence for both diet and physical activity, but only found positive evidence of cost-effectiveness for physical activity. One review investigated the cost-effectiveness of sun-protection MMCs. This was a meta-analysis which looked into the cost-effectiveness of three campaigns in Australia[72] and found positive results. No reviews on the cost-effectiveness of MMCs for the remaining health behaviours of interest (alcohol use, cancer screening uptake, HPV vaccination, and symptomatic GP presentation) met the review inclusion criteria.

Table 2 . Summary of reviews and their cost-effectiveness, by health behaviour

Behaviour	Review details	Numbers and relevance* of studies included in reviews	Summary conclusions
Tobacco use	Bala et al., 2017[11]	11 total - 11 relevant studies	<i>Positive evidence for cost-effectiveness</i>
	Atusingwize et al., 2015[61]	11 relevant studies Mass media sole focus	
	Brinn et al., 2012[23]	7 total – 1 relevant studies Mass media sole focus	
	Kahende et al., 2009[62]	42 total – 2 relevant studies Mass media not sole focus	
	Mason et al., 2008[63]	8 total – 1 relevant studies Mass media not sole focus	
	Multiple behaviour		
	Flack et al., 2007[64]	10 total – 3 relevant studies Mass media sole focus	
	Raikou & McGuire, 2007[65]	5 total – 2 relevant studies Mass media not sole focus	
	Hutchinson & Wheeler, 2006[66] Multiple behaviour: smoking cessation, sexual health and substance abuse	45 total – 3 relevant studies Mass media not sole focus	
	Lantz et al., 2000[67]	1 relevant study Mass media not sole focus	
Diet	McKinnon et al., 2016[68] Multiple behaviours: obesity -	27 total – 2 relevant studies Mass media not sole focus	<i>Positive evidence for cost-effectiveness</i>

	Nutrition and physical activity		
	Wang & Bowman, 2013[71]	6 total – 1 relevant studies Mass media not sole focus	
	Wang & Labarthe, 2011[70]	11 total – 1 relevant study Mass media not sole focus	
Physical activity	McKinnon et al., 2016[68] Multiple behaviours: obesity nutrition and physical activity	27 total – 2 relevant studies Mass media not sole focus	<i>Positive evidence for cost-effectiveness</i>
	Laine et al., 2014[69]	10 total – 1 relevant study Mass media not sole focus	
Skin cancer prevention	Doran et al., 2016[72]	3 relevant studies Mass media sole focus	<i>Positive evidence for cost-effectiveness</i>
<i>* relevance relates to the study's focus on MMCs and the behavioural outcomes of interest</i>			

Discussion

This review examined the impact of MMCs on a wide range of cancer-related behaviours including cancer prevention (tobacco use, diet, alcohol use, physical activity, sun and UV-protection, and HPV vaccination), cancer screening uptake, and symptomatic GP presentation. We also examined the cost-effectiveness of MMCs for these behaviours. These results provide an update on the evidence base for behaviours relating to cancer prevention, screening and early diagnosis since Wakefield et al.'s review[13] and report on a wider range of cancer-related behaviours than the most recent systematic review by Stead et al.[10]

We found strong positive evidence for dietary behaviours and cancer screening uptake, moderate positive evidence for sun and UV protection behaviours, and weak positive evidence for HPV vaccination uptake. There was strong but mixed evidence for the effectiveness of MMCs on tobacco use, and moderate mixed evidence for physical activity. There was insufficient evidence for alcohol use, and no reviews on symptomatic GP presentation met the review inclusion criteria. These results are in line with previous reviews.[10, 13, 40, 51] For all behaviours, MMCs were more likely to be effective when part of multi-component and community-based interventions. These additional components often increased availability and accessibility of services and support and may be crucial in enabling individuals motivated by media messages to act on their intentions. MMCs also tended to be more effective when using targeted activity and messages, stronger messages, longer campaign durations, and the use of multiple media types. This was particularly the case for frequent behaviours such as tobacco use or physical activity, where evidence showed poor outcomes when MMCs were used in isolation. Wakefield et al.[13] and Stead et al.[10] reported similar findings. Overall, more positive effects of MMCs were observed for infrequent behaviours (e.g. cancer screening and vaccination) than frequent behaviours (e.g. tobacco use and physical activity) – a trend which was also reported by Wakefield et al.[13] It may be more difficult for MMCs to change more complex behaviours (e.g. smoking or alcohol use), due to the complex interplay of factors associated with these behaviours which may be rooted in addiction,[10] and more support may be needed to complement the impact of mass media messages.

There were a limited number of reviews examining cost-effectiveness of mass media activity on health behaviours. We saw positive evidence for cost-effectiveness of campaigns on smoking. Considering the mixed evidence for the effectiveness of campaigns on tobacco use, this should be interpreted cautiously as mostly successful campaigns were evaluated for cost-effectiveness. Evidence for the cost-effectiveness of campaigns on diet, physical activity, and sun-protection behaviour was also positive. However, for sun-protection behaviours, the results are based on one review that included only three studies. Our results were identical to those by Stead et al.[10] – with the exception of sun and UV-protection behaviours, which they didn't assess – as no reviews published after 2017 reporting on cost-effectiveness met our inclusion criteria for the remaining behaviours.

Strengths of this review include the investigation of a wide range of cancer prevention, screening and early diagnosis behaviours, as well as examining cost-effectiveness. Moreover,

we assessed review quality using the ROBIS tool, although an assessment of individual studies within the reviews was not possible. Further, we focused on the impact of MMCs on actual behaviour change rather than determinants of behaviour, such as knowledge and attitudes, which may not translate to actual behaviour change. A weakness of this review is that a meta-analysis approach was not possible, due to high heterogeneity in the types of included reviews (meta-analyses and narrative), measures of behaviour change, campaign effectiveness and cost-effectiveness, socio-economic status indices, campaign and follow-up durations. Also, due to the broad range of topics covered, we conducted a review of systematic reviews, which means that individual studies not included within systematic reviews have not been included. Further, this research examined traditional forms of mass media which excludes the emerging interactive online and new media such as apps – a growing form of health behaviour campaign which was outside the scope of this work. These other forms of media could help target deprived groups, which may reduce the inequalities posed by non-targeted mass campaigns, and therefore worth exploring in future work.[73] Finally, many reviews included in this review evaluated multicomponent MMC interventions, which made it difficult to disentangle the effects of MMC and other intervention components.

Conclusion

Based on this review of reviews, MMCs may be more effective in changing infrequent than frequent health behaviours. They are also more likely to be effective when used as part of multi-component, community-based interventions that also include service provision, altered environments and fiscal/policy measures. More research is needed to assess cost-effectiveness of MMCs. Results of this work can support organisations, policy makers, and healthcare providers in decision-making related to improving health behaviours in populations.

Appendix

Databases searched and search terms

Date Searched:

September 2020

Databases searched

EMBASE, PubMed, Medline, Web of Science

PubMed Search Strategy

“review” or “meta-analys*”

AND “health promotion” or “health education” or “social marketing” or “marketing of health services” or “campaign*” or “mass media*” or “mass communication campaign*” or “publicity campaign*” or “information campaign*” or “community intervention*”

Along with and the individual health behaviours of interest, one at a time.
Therefore AND:

“smoking” or “smoke” or “tobacco” or “cigarette” or “smoking cessation” or “smoking reduction”

“physical activ*” or “exercise” or “sport*” or “activ*” or “obesity” or “weight” or “overweight” or “nutrition*” or “high fat*” or “diet” or “healthy eating” or “vegetable*” or “calori*”

“early diagnosis” or “early detection of cancer” or “early presentation” or “early diagnos*” or “early detection cancer” or “screening” AND “neoplasm*” or “cancer*” or “tumor*”

“uterine cervical neoplasms” or “cervical cancer” or “neoplasm” or “carcin*” or “CIN” or “dysplasia” AND “screening” or “smear” or “pap” or “test”

“breast neoplasms” or “breast cancer” or “neoplasm” or “carcin*” AND “screening” or “mammo*” or “x-ray”

“colorectal neoplasms” or “bowel cancer” or “neoplasm” or “carcin*” or “colorectal” AND
“screening” or “colonoscopy” or “FIT” or “FOBT” or “occult”

“skin neoplasm*” or “sunburn” or “sunscreening agents” or “skin cancer” or “melanoma” or
“carcinoma” or “basal cell” or “squamous cell” or “keratosis” or “sun damage” or “skin aging”
or “solar keratos*” or “UV protection” or “sun protection”

“immuniz*” or “immunis*” or “vaccin*” or “HPV” or “cervical cancer”

For cost effectiveness, the above method, in addition to:

“cost” or “benefit” or “cost-effectiveness” or “economic*” or “economic evaluation” or “cost
savings” or “cost benefit” or “economic impact”

Risk of bias assessment criteria

The strength of evidence for each health behaviour was considered to be strong if more than 60% of reviews had low risk of bias, moderate if 40-60% of the reviews had a low risk of bias, and weak if less than 40% of reviews had low risk of bias.

References

1. Ferlay J, Colombet M, Soerjomataram I, et al. Estimating the global cancer incidence and mortality in 2018: GLOBOCAN sources and methods. *International journal of cancer*. 2019; **144**: 1941-53.
2. Cancer Research UK. Cancer Statistics for the UK [Available from: <https://www.cancerresearchuk.org/health-professional/cancer-statistics-for-the-uk#heading-Zero>].
3. Brown KF, Rungay H, Dunlop C, et al. The fraction of cancer attributable to modifiable risk factors in England, Wales, Scotland, Northern Ireland, and the United Kingdom in 2015. *British journal of cancer*. 2018; **118**: 1130-41.
4. Landy R, Pesola F, Castañón A, Sasieni P. Impact of cervical screening on cervical cancer mortality: estimation using stage-specific results from a nested case–control study. *British journal of cancer*. 2016; **115**: 1140-6.
5. Walters S, Maringe C, Coleman MP, et al. Lung cancer survival and stage at diagnosis in Australia, Canada, Denmark, Norway, Sweden and the UK: a population-based study, 2004–2007. *Thorax*. 2013; **68**: 551-64.
6. Ciccolallo L, Capocaccia R, Coleman M, et al. Survival differences between European and US patients with colorectal cancer: role of stage at diagnosis and surgery. *Gut*. 2005; **54**: 268-73.
7. Sant M, Allemani C, Capocaccia R, et al. Stage at diagnosis is a key explanation of differences in breast cancer survival across Europe. *International journal of cancer*. 2003; **106**: 416-22.
8. Maringe C, Walters S, Butler J, et al. Stage at diagnosis and ovarian cancer survival: evidence from the International Cancer Benchmarking Partnership. *Gynecol Oncol*. 2012; **127**: 75-82.
9. Davis RM, Gilpin EA, Loken B, Viswanath K, Wakefield MA. The role of the media in promoting and reducing tobacco use. USA; 2008.
10. Stead M, Angus K, Langley T, et al. Mass media to communicate public health messages in six health topic areas: a systematic review and other reviews of the evidence. 2019.
11. Bala MM, Strzeszynski L, Topor-Madry R. Mass media interventions for smoking cessation in adults. *Cochrane Db Syst Rev*. 2017.
12. Thomas MM, Phongsavan P, McGill B, O'Hara BJ, Bauman AE. A review of the impact of physical activity mass media campaigns on low compared to high socioeconomic groups. *Health education research*. 2018; **33**: 429-46.
13. Wakefield MA, Loken B, Hornik RC. Use of mass media campaigns to change health behaviour. *Lancet*. 2010; **376**: 1261-71.
14. World Health Organization. Road safety mass media campaigns: A toolkit. 2016.
15. Brown T, Platt S, Amos A. Equity impact of population-level interventions and policies

to reduce smoking in adults: a systematic review. *Drug Alcohol Depen.* 2014; **138**: 7-16.

16. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Int J Surg.* 2010; **8**: 336-41.

17. Secker-Walker R, Gnich W, Platt S, Lancaster T. Community interventions for reducing smoking among adults. *Cochrane Db Syst Rev.* 2002.

18. Whiting P, Savović J, Higgins JP, et al. ROBIS: a new tool to assess risk of bias in systematic reviews was developed. *J Clin Epidemiol.* 2016; **69**: 225-34.

19. Carson-Chahhoud KV, Ameer F, Sayehmiri K, et al. Mass media interventions for preventing smoking in young people. *Cochrane Db Syst Rev.* 2017.

20. Chamberlain C, Perlen S, Brennan S, et al. Evidence for a comprehensive approach to Aboriginal tobacco control to maintain the decline in smoking: an overview of reviews among Indigenous peoples. *Systematic reviews.* 2017; **6**: 135.

21. de Kleijn MJ, Farmer MM, Booth M, et al. Systematic review of school-based interventions to prevent smoking for girls. *Systematic reviews.* 2015; **4**: 109.

22. Brown T, Platt S, Amos A. Equity impact of interventions and policies to reduce smoking in youth: systematic review. *Tobacco control.* 2014; **23**: e98-e105.

23. Brinn MP, Carson KV, Esterman AJ, Chang AB, Smith BJ. Cochrane Review: Mass media interventions for preventing smoking in young people. *Evidence-Based Child Health: A Cochrane Review Journal.* 2012; **7**: 86-144.

24. Wilson LM, Avila Tang E, Chander G, et al. Impact of tobacco control interventions on smoking initiation, cessation, and prevalence: a systematic review. *Journal of environmental and public health.* 2012; **2012**.

25. Richardson L, Allen P, McCullough L, et al. Interventions to prevent the uptake of smoking in children and young people. *Vancouver (Canada): Centre of Excellence for Women's Health.* 2007.

26. Ellis P, Robinson P, Ciliska D, et al. Diffusion and Dissemination of Evidence-Based Cancer Control Interventions: Summary. AHRQ Evidence Report Summaries: Agency for Healthcare Research and Quality (US); 2003.

27. Derzon JH, Lipsey MW. A meta-analysis of the effectiveness of mass-communication for changing substance-use knowledge, attitudes, and behavior. *Mass media and drug prevention: Classic and contemporary theories and research.* 2002: 231-58.

28. Mosdøl A, Lidal IB, Straumann GH, Vist GE. Targeted mass media interventions promoting healthy behaviours to reduce risk of non-communicable diseases in adult, ethnic minorities. *Cochrane Db Syst Rev.* 2017.

29. Robinson MN, Tansil KA, Elder RW, et al. Mass media health communication campaigns combined with health-related product distribution: a community guide systematic review. *American journal of preventive medicine.* 2014; **47**: 360-71.

30. Gould GS, McEwen A, Watters T, Clough AR, van der Zwan R. Should anti-tobacco media messages be culturally targeted for Indigenous populations? A systematic review and narrative synthesis. *Tobacco control.* 2013; **22**: e7-e.

31. Guillaumier A, Bonevski B, Paul C. Anti-tobacco mass media and socially disadvantaged

- groups: A systematic and methodological review. *Drug and alcohol review*. 2012; **31**: 698-708.
32. Hemsing N, Greaves L, O'Leary R, Chan K, Okoli C. Partner support for smoking cessation during pregnancy: a systematic review. *Nicotine Tob Res*. 2011; **14**: 767-76.
 33. Jepson R, Harris FM, Rowa-Dewar NJ, et al. A review of the effectiveness of mass media interventions which both encourage quit attempts and reinforce current and recent attempts to quit smoking. 2007.
 34. Mozaffarian D, Afshin A, Benowitz NL, et al. Population approaches to improve diet, physical activity, and smoking habits: a scientific statement from the American Heart Association. *Circulation*. 2012; **126**: 1514-63.
 35. Byrne AM, Dickson L, Derevensky JL, Gupta R, Lussier I. The application of youth substance use media campaigns to problem gambling: A critical evaluation. *J Health Commun*. 2005; **10**: 681-700.
 36. Matson-Koffman DM, Brownstein JN, Neiner JA, Greaney ML. A site-specific literature review of policy and environmental interventions that promote physical activity and nutrition for cardiovascular health: what works? *Am J Health Promot*. 2005; **19**: 167-93.
 37. Pomerleau J, Lock K, Knai C, McKee M. Interventions designed to increase adult fruit and vegetable intake can be effective: a systematic review of the literature. *The Journal of nutrition*. 2005; **135**: 2486-95.
 38. Abril EP, Dempsey PR. Outcomes of healthy eating ad campaigns: A systematic review. *Progress in cardiovascular diseases*. 2019; **62**: 39-43.
 39. Pomerleau J, Lock K, Knai C, McKee M. Interventions designed to increase adult fruit and vegetable intake can be effective: A systematic review of the literature. *J Nutr*. 2005; **135**: 2486-95.
 40. Young B, Lewis S, Katikireddi SV, et al. Effectiveness of mass media campaigns to reduce alcohol consumption and harm: a systematic review. *Alcohol and alcoholism*. 2018; **53**: 302-16.
 41. Anderson P, Chisholm D, Fuhr DC. Effectiveness and cost-effectiveness of policies and programmes to reduce the harm caused by alcohol. *The lancet*. 2009; **373**: 2234-46.
 42. Moreira MT, Smith LA, Foxcroft D. Social norms interventions to reduce alcohol misuse in university or college students. *Cochrane Db Syst Rev*. 2009.
 43. Abioye AI, Hajifathalian K, Danaei G. Do mass media campaigns improve physical activity? a systematic review and meta-analysis. *Archives of Public Health*. 2013; **71**: 20.
 44. Ogilvie D, Foster CE, Rothnie H, et al. Interventions to promote walking: systematic review. *bmj*. 2007; **334**: 1204.
 45. Brown DR, Soares J, Epping JM, et al. Stand-alone mass media campaigns to increase physical activity: a community guide updated review. *American journal of preventive medicine*. 2012; **43**: 551-61.
 46. Kahn EB, Ramsey LT, Brownson RC, et al. The effectiveness of interventions to increase physical activity: a systematic review. *American journal of preventive medicine*. 2002; **22**: 73-107.
 47. Finlay S-J, Faulkner G. Physical activity promotion through the mass media: inception,

production, transmission and consumption. *Prev Med.* 2005; **40**: 121-30.

48. Leavy JE, Bull FC, Rosenberg M, Bauman A. Physical activity mass media campaigns and their evaluation: a systematic review of the literature 2003–2010. *Health education research.* 2011; **26**: 1060-85.

49. Saraiya M, Glanz K, Briss PA, et al. Interventions to prevent skin cancer by reducing exposure to ultraviolet radiation: a systematic review. *American journal of preventive medicine.* 2004; **27**: 422-66.

50. Sandhu PK, Elder R, Patel M, et al. Community-wide interventions to prevent skin cancer: two community guide systematic reviews. *American journal of preventive medicine.* 2016; **51**: 531-9.

51. Smulian EA, Mitchell KR, Stokley S. Interventions to increase HPV vaccination coverage: a systematic review. *Human vaccines & immunotherapeutics.* 2016; **12**: 1566-88.

52. Niccolai LM, Hansen CE. Practice-and community-based interventions to increase human papillomavirus vaccine coverage: a systematic review. *JAMA pediatrics.* 2015; **169**: 686-92.

53. Schliemann D, Su TT, Paramasivam D, et al. Effectiveness of Mass and Small Media Campaigns to Improve Cancer Awareness and Screening Rates in Asia: A Systematic Review. *Journal of global oncology.* 2019; **5**: 1-20.

54. Adedoyin AC, Sherr ME, Adedoyin OO, Royse DD, Jackson MS, Adu-Boahene AB. The Characteristics of Effective Cancer Education Media Interventions among African Americans: A Systematic Review. *Journal of evidence-informed social work.* 2016; **13**: 331-44.

55. Baron RC, Rimer BK, Breslow RA, et al. Client-directed interventions to increase community demand for breast, cervical, and colorectal cancer screening: a systematic review. *American journal of preventive medicine.* 2008; **35**: S34-S55.

56. Snyder LB, Hamilton MA, Mitchell EW, Kiwanuka-Tondo J, Fleming-Milici F, Proctor D. A meta-analysis of the effect of mediated health communication campaigns on behavior change in the United States. *J Health Commun.* 2004; **9**: 71-96.

57. Brouwers MC, De Vito C, Bahirathan L, et al. What implementation interventions increase cancer screening rates? A systematic review. *Implementation Science.* 2011; **6**: 1-17.

58. Black ME, Yamada J, Mann V. A systematic literature review of the effectiveness of communitybased strategies to increase cervical cancer screening. *Canadian journal of public health.* 2002; **93**: 386-93.

59. Martini A, Morris JN, Preen D. Impact of non-clinical community-based promotional campaigns on bowel cancer screening engagement: An integrative literature review. *Patient education and counseling.* 2016; **99**: 1549-57.

60. Saab MM, Landers M, Hegarty J. Promoting testicular cancer awareness and screening: A systematic review of interventions. *Cancer nursing.* 2016; **39**: 473-87.

61. Atusingwize E, Lewis S, Langley T. Economic evaluations of tobacco control mass media campaigns: a systematic review. *Tobacco Control.* 2015; **24**: 320-7.

62. Kahende J, Loomis B, Adhikari B, Marshall L. A review of economic evaluations of tobacco control programs. *International journal of environmental research and public health.*

2009; **6**: 51-68.

63. Mason AR, Carr Hill R, Myers LA, Street AD. Establishing the economics of engaging communities in health promotion: what is desirable, what is feasible? *Critical Public Health*. 2008; **18**: 285-97.

64. Flack S, Taylor M, Trueman P. Cost-effectiveness of interventions for smoking cessation. *York Health Economics Consortium*. 2007.

65. Raikou M, McGuire A. A review of the cost-effectiveness of interventions (specifically point of sales measures and mass media) to prevent the uptake of smoking in young people under 18 years old. *National Institute for Health and Clinical Excellence*. 2007.

66. Hutchinson P, Wheeler J. The cost-effectiveness of health communication programs: What do we know? *J Health Commun*. 2006; **11**: 7-45.

67. Lantz PM, Jacobson PD, Warner KE, et al. Investing in youth tobacco control: a review of smoking prevention and control strategies. *Tobacco control*. 2000; **9**: 47-63.

68. McKinnon RA, Siddiqi SM, Chaloupka FJ, Mancino L, Prasad K. Obesity-related policy/environmental interventions: a systematic review of economic analyses. *American journal of preventive medicine*. 2016; **50**: 543-9.

69. Laine J, Kuvaja-Köllner V, Pietilä E, Koivuneva M, Valtonen H, Kankaanpää E. Cost-effectiveness of population-level physical activity interventions: a systematic review. *Am J Health Promot*. 2014; **29**: 71-80.

70. Wang G, Labarthe D. The cost-effectiveness of interventions designed to reduce sodium intake. *Journal of hypertension*. 2011; **29**: 1693.

71. Wang G, Bowman BA. Recent economic evaluations of interventions to prevent cardiovascular disease by reducing sodium intake. *Current atherosclerosis reports*. 2013; **15**: 349.

72. Doran CM, Ling R, Byrnes J, et al. Benefit cost analysis of three skin cancer public education mass-media campaigns implemented in New South Wales, Australia. *Plos One*. 2016; **11**: e0147665.

73. Welch V, Petkovic J, Pardo JP, Rader T, Tugwell P. Interactive social media interventions to promote health equity: an overview of reviews. *Health promotion and chronic disease prevention in Canada: research, policy and practice*. 2016; **36**: 63.