ABSTRACT

Purpose: To evaluate and summarize evidence on the effectiveness of interventions available to public health staff regarding the protection of the public from environmental risks.

Method: This systematic review involved a comprehensive literature search, screening for relevance, quality assessment of relevant studies, data extraction and synthesis.

Results: Fourteen of 65 relevant studies were of 'moderate' or 'strong' quality. Intervention types in these 14 studies included: mass campaign, counselling, school curriculum, educational sessions, and distribution of printed materials. Short-term improvements in awareness or knowledge were observed in 13 of the 14 studies. Eight of 13 studies that examined behavioural outcomes observed short-term improvements in self-reported behavioural outcomes.

Conclusions: Positive short-term changes in health-protective awareness, knowledge and self-reported behaviour appear to be associated with relatively intensive interventions that use multiple methods and settings, and/or are delivered over multiple sessions.

ABRÉGÉ

Objet : Évaluer et résumer les preuves de l'efficacité des interventions dont dispose le personnel de la santé publique pour protéger la population contre les risques liés à l'environnement.

Méthode : Cette étude systématique s'est composée d'une analyse documentaire exhaustive, d'un tri des résultats en fonction de leur pertinence, d'une évaluation de la qualité des études sur la question et de l'extraction et de la synthèse des données.

Résultats : Quatorze des 65 études pertinentes étaient de qualité « moyenne » ou « élevée ». Parmi les types d'intervention recensés dans ces 14 études, on trouve les campagnes de masse, le counseling, les séances de sensibilisation et la diffusion de documents imprimés. Dans 13 des 14 études, on a observé des améliorations rapides de la prise de conscience et de la connaissance du sujet. Dans 8 des 13 études portant sur les résultats comportementaux, on a observé des améliorations rapides dans les résultats déclarés par les répondants.

Conclusions : Les changements positifs rapides (sensibilisation aux mesures de protection de la santé, connaissances et modification auto-déclarée du comportement) semblent associés aux interventions relativement intensives, qui ont recours à de multiples méthodes et milieux ambiants, et (ou) sont répétées à maintes reprises.

A Systematic Review of the Effectiveness of Environmental Awareness Interventions

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The Canadian public is chronically exposed to a wide range of environmental pollutants and hazardous agents.¹⁻³ Some agents, such as ultraviolet (UV) radiation⁴ and lead,⁵ can clearly result in adverse health effects. For other agents, such as electromagnetic fields (EMFs)⁶ and hormonally active environmental contaminants,⁷ there appears to be cause for concern, but the evidence for adverse health effects is not as strong. Nonetheless, public concern about the potential effects of the biophysical environment on human health remains high and generates many inquiries for response by public health units.

The Ontario Ministry of Health requires health units to prevent or reduce adverse health outcomes resulting from exposure to hazardous agents in the environment.⁸ This is to be done by: employing effective health hazard management strategies; consulting with and providing advice to the community

about environmental risks; and providing educational materials to raise public awareness.⁸ The challenge for health unit staff is to ensure that the general population and those sub-populations at greatest risk are aware of environmental risks to their health; are aware of their capacity to improve environmental conditions or avoid environmental hazards; and are taking appropriate measures to protect themselves and their families.

The purpose of this study was to examine the effectiveness of interventions available to public health staff that could be used to enable the public to protect itself from environmental risks to health. The interventions examined in this study included a variety of health promotion strategies such as educational sessions, curriculum development, networking and coalition development, counselling, mass campaigns, home assessment, workshops and health fairs. The environmental hazards of interest included chemical, physical and biological agents such as air pollutants, water contaminants, land contamination, trace toxics in foods, UV radiation (due to link with ozone layer depletion) and pesticides.

The systematic review sought to answer the research question: "What is the effectiveness of community-based interventions applicable to public health practice in promoting public awareness of environmental risks to health or adoption of risk reduction measures?" This paper evaluates and summarizes the evidence on the effectiveness of environmental awareness interventions.

METHOD

Literature search

A systematic search of published and unpublished studies was conducted during

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September and October 1998. The following databases were searched: Cochrane Library, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Dissertation Abstracts, Embase, Medline, National Technical Information Service (NTIS), and Environmental Science and Pollution Abstracts. The computer-based search included primary and review studies in all languages available since 1978. Boolean searching was used to combine 60 key words and/or MESH headings. Key words were categorized by: effectiveness (e.g., evaluation, efficacy); intervention (e.g., campaign, counselling); and environmental hazard (e.g., air pollution, pesticides). A hand-search of key journals for the previous five years was conducted. Public health epidemiologists and key informants were contacted to identify and retrieve unpublished studies.

Relevance and quality assessment

Studies were assessed as relevant if they met all of the inclusion criteria in Table I. After establishing a high level of agreement ($\kappa > 0.8$) among two reviewers regarding the decision to include/exclude the first 400 abstracts, one reviewer screened the approximately 8,000 remaining abstracts. Both reviewers participated in the secondary screening process, applying the relevance tool independently to each of 194 studies selected for retrieval.

Staff of the *Effective Public Health Practice Project* developed a generic quality assessment tool to use in nine systematic reviews undertaken by Ontario's Public Health Research, Education and Development Partnership (PHRED) for the Ontario Ministry of Health. Diverse staff from public health units and affiliated academic institutions collaboratively developed the tool. Multiple reviewers pilot-tested the tool on several studies and found it to result in consistent (reliable) assessments of methodological quality.

The internal validity of each study was based on how well it scored on six component ratings. The criteria used to develop the component ratings and their scoring are shown in Table II. Two reviewers read each relevant study to independently assess quality and extract descriptive data. The final assessment of each study was deter-

TABLE I Selection Criteria for Study Inclusion/Exclusion	
Criterion	Description
Type of Study	All design types eligible. Only primary studies eligible, however, review studies retrieved and examined for primary studies.
Study Scope	Studies eligible if they involved environmental hazards (e.g., hazardous agents in air, water, food, soil).
Participants	Studies eligible if ultimate target was general public. Occupational studies were excluded.
Interventions	Studies eligible if interventions fell within scope of public health practice in Canada, such that public health staff could implement, facilitate or promote these interventions.
Outcome Measures	Studies eligible if outcome measures were used to assess intervention. Studies that evaluated only process (rather than outcome) measures were not eligible.

TABLE II Criteria to Assess Internal Validity	
Component	Criteria*
Selection Bias	Were selected individuals representative of target population? What was participation rate?
Study Design	If randomized and/or controlled trial, rate as 'strong'. If cohort, case-control or time series, rate as 'moderate'.
Confounders	Were important confounders controlled for?
Blinding	Was outcome assessor aware of intervention status of participants?
Data Collection	Were study participants aware of allocation status or research question? Were data collection tools shown to be valid?
Withdrawals	Were data collection tools shown to be reliable? How many participants enrolled in study were available for outcome assessment?

* Scoring: Study rated as 'strong' if it had 4 strong and no weak component ratings; 'moderate' if it had less than 4 strong component ratings and 1 weak rating; and 'weak' if it had 2 or more weak component ratings.

mined by consensus between the two reviewers. A relational database management system (Access 97, Microsoft Corp., Redmond, WA) was used to facilitate the handling of data associated with the review process.

RESULTS

Study characteristics

Of the 194 articles selected for retrieval based on relevancy of their abstracts, 182 (94%) were available for retrieval. Each of these complete studies was subjected to another cycle of relevance testing. This yielded 65 relevant studies. Evaluation research on this topic area is relatively recent, with 63 studies conducted in the 1990s and only 2 conducted prior to 1990. Table III summarizes the characteristics of the 65 relevant studies. The most common research design used to evaluate environmental awareness interventions was cross-sectional, accounting for 38% (25/65) of relevant studies. Regarding the type of environmental hazard examined, the majority of studies evaluated interventions involving UV radiation from the sun,

TABLE III Characteristics of Relevant Studies	
Characteristic	Number of Studies
Study Design	
Cross-sectional	25
Randomized controlled trial (RCT)	17
Uncontrolled cohort	12
Controlled trial	5
Time series	4
Controlled cohort	1
Other	1
Environmental Hazard	
Ultraviolet (UV) radiation	33
Environmental tobacco smoke (ETS)	10
Toxics (multiple, household, spill)	6
Food contamination (chemical residues)	4
Lead	3
Radon	4
Air quality (outdoor, indoor)	2
Water quality	2
Electro-magnetic fields (EMFs)	1
Intervention Type	
Mass campaign	24
Distribution of printed materials	13
Educational session	10
Counselling	8
School curriculum	6
Site visit	3
Policy implementation	1

accounting for 51% (33/65) of all studies. Mass campaigns were the most common type of environmental awareness intervention evaluated. However, cross-sectional

TABLE IV
Summary of Interventions and Outcomes for 'Strong' and 'Moderate' Studies

STUDY (Country)	DESIGN (Quality Assessment*)	INTERVENTION	OUTCOMES	COMMENTS
Counselling				
Huss, 1992 ⁹ (U.S.A.)	RCT (strong)	Hazard: indoor air quality Target: adults with mite-associated asthma (26 intervention; 26 control) Intervenor: physicians & nurses Setting: medical office Description: Intervention group received conventional counselling plus interactive instruction by computer to increase mite-avoidance measures at home.	Conventional counselling supplemented with computer instruction significantly increased mite-avoidance behaviours ($p<0.05$); reduced mite levels at home ($p<0.01$); and reduced symptom reporting ($p<0.05$).	Provides evidence that addition of computer-based instruction to conventional counselling is effective in improving mite-avoidance behaviours. Concerns about generalizability given small number of patients from single clinic.
Strecher, 1993 ¹⁰ (U.S.A.)	RCT (moderate [a])	Hazard: ETS Target: families of newborns (292 intervention; 293 control) Intervenor: public health nurses Setting: home Description: Intervention group received 4 (45-min.) visits during infant's first 6 months to increase parental outcome and self-efficacy expectations regarding protection of infant from ETS.	Intervention produced significant and sustained improvements in outcome and efficacy expectations at 7 and 12 months ($p<0.001$).	Provides evidence that home-based counselling can increase protection of infants from ETS. Concerns about selection bias, given less than 25% of eligible families participated.
Wahlgren, 1997 ¹¹ (U.S.A.)	RCT (moderate [d])	Hazard: ETS Target: smokers & asthmatic children (6-17 years) ($n=91$) Intervenor: medical staff Setting: medical clinic, home Description: Intervention group received behavioural counselling, self-monitoring assistance and extensive educational resources.	Significantly more parents in counselling group ($p<0.05$) eliminated their child's exposure to ETS, compared with control groups.	Provides evidence that counselling supplemented with self-monitoring assistance & educational resources can be effective in long-term protection of asthmatic children from ETS. Concerns about self-report to assess smoking status & ETS exposure.
Distribution of printed materials				
McIntosh, 1994 ¹² (U.S.A.)	RCT (moderate [e])	Hazard: ETS Target: parents of asthmatic children (44 intervention, 48 control) Intervenor: physician Setting: medical office & home Description: Intervention group received urine cotinine feedback and self-help manual about not smoking at home, in addition to minimal-contact 'usual care' counselling received by control group.	Significantly more intervention parents tried to quit smoking in the home (86% intervention vs. 43% controls, $p<0.001$). Cotinine levels in intervention children lower, but not significantly so.	Provides evidence of effectiveness of educational resources in increasing positive behavioural intent, however intervention limited in shifting actual behaviour.
McMahan, 1997 ¹³ (U.S.A.)	RCT (strong)	Hazard: EMFs Target: college students ($n=251$) Intervenor: researcher Setting: college Description: Using the same information base, one group received 'high-threat' messages, whereas another group received 'low-threat' messages in written materials on EMFs.	Significantly more (46%, $p<0.001$) students who read high-threat messages adopted EMF exposure reduction behaviours compared with low-threat group (9%).	Provides evidence that high-threat messages can be more effective in enhancing EMF exposure reduction behaviours than low-threat ones. Concerns about generalizability, given homogeneous, educated sample population.

continued...

TABLE IV — CONTINUED
Summary of Interventions and Outcomes for 'Strong' and 'Moderate' Studies

STUDY	DESIGN	INTERVENTION	OUTCOMES	COMMENTS
Educational session				
Katz, 1991 ¹⁴ (U.S.A.)	RCT (moderate [c])	Hazard: UV radiation Target: college students Intervenor: researcher Setting: college Description: Intervention group (n=17) received 30-min. slideshow and question & answer period about sun safety.	Students in intervention group had significantly ($p<0.001$) higher knowledge scores compared to those without training.	Provides evidence for effectiveness of an educational session in increasing sun safety knowledge. Generalizability limited due to selective population.
Mayer, 1997 ¹⁵ (U.S.A.)	RCT (strong)	Hazard: UV radiation Target: Children (6 - 9 years) enrolled in swimming classes (84 intervention, 85 control children). Intervenor: swimming instructors Setting: poolside at recreation centres Description: Intervention group received 5-min. SUNWISE lesson at each of 4 swimming lessons. Take-home resources provided to parents.	Intervention group had significantly greater ($p<0.05$) use of hats than control group, however, there were no significant differences in tanness, solar protection scores or sunscreen use.	Intervention not effective in increasing solar protection behaviour, other than for hat use. Limitations noted were short duration of educational session, and short time interval for measuring tanness.
Mermelstein, 1992 ¹⁶ (U.S.A.)	RCT (moderate [f])	Hazard: UV radiation Target: adolescents (n=1,703) Intervenor: researcher Setting: high schools (5 intervention, 5 control) Description: Intervention group participated in 45-min. class on sun safety, consisting of video, lecture & discussion.	Intervention significantly ($p<0.001$) increased knowledge and perceived susceptibility to skin cancer. Behavioural intentions improved slightly but were not statistically significant.	Provides evidence of effectiveness of educational session in increasing sun safety knowledge & attitudes, but not practices.
Mass Campaign				
Dietrich, 1998 ¹⁷ (U.S.A.)	RCT (moderate [e])	Hazard: UV radiation Target: children, families, caregivers Intervenor: physicians, teachers, day care staff, lifeguards Setting: community (5 control, 5 intervention towns) Description: Intervention communities received sun safety messages in variety of ways through multicomponent Sun Safe program. Program components included counselling, educational sessions, displays, educational materials, posters, sunscreen samples.	Based on observation of 1,930 children at the beach, significantly more children (76%, $p<0.05$) in intervention towns used sunscreens than in control towns (56%).	Provides evidence that mass public education campaign can increase solar protection behaviour of children through increased use of sunscreen. Limited in that beach-going public may not be representative of larger community.
Graham-Brown, 1990 ¹⁸ (United Kingdom)	Time Series (moderate)	Hazard: UV radiation Target: adults Intervenor: health association Setting: community Description: Media campaign (newspapers, radio, television) was implemented to increase public awareness of skin lesions and medical assessment.	After campaign, significant increases ($p<0.001$) in new patients at clinics (up 350%) and melanomas detected (up 90%), compared with before.	Provides evidence for effectiveness of mass campaign in increasing melanoma awareness and detection.
Pehamberger, 1993 ¹⁹ (Austria)	Time Series (moderate [a])	Hazard: UV radiation Target: public, physicians Intervenor: health association Setting: community Description: Multimedia (television, newspapers) campaign, including dissemination of educational materials.	Significant ($p<0.01$) increase in annual melanoma detection rates from 130 (before) to 189 during campaign.	Provides evidence for effectiveness of mass campaign in increasing early detection of melanoma through patient self-examination & physician assessment.

continued...

TABLE IV — CONTINUED
Summary of Interventions and Outcomes for 'Strong' and 'Moderate' Studies

STUDY	DESIGN	INTERVENTION	OUTCOMES	COMMENTS
School curriculum				
Buller, 1997 ²⁰ (U.S.A.)	RCT (moderate)	Hazard: UV radiation Target: children (grade 4, n=318) Intervenor: teachers Setting: schools (n=3) Description: Intervention consisted of two formats for increasing sun safety: (1) 1-hour lesson in classroom with take-home resources; and (2) interactive sun safety fair with activity centres (45 - 90 min, duration).	Both classroom session and health fair significantly ($p<0.05$) improved children's knowledge and attitudes compared with control group, however, solar protection practices did not increase.	Provides evidence for effectiveness of either classroom-based session or school-based health fair to enhance sun safety knowledge & attitudes, but not practices. Some concern that unit of allocation was class but unit of analysis was individual.
Girgis, 1993 ²¹ (Australia)	RCT (strong)	Hazard: UV radiation Target: children (9-11 years) Intervenor: teachers Setting: schools (n=11) Description: Schools were allocated to: (1) intensive intervention; (2) standard intervention; and (3) control. Intensive intervention was an extensive sun safety program incorporated into many subject areas over 4-week period. Standard intervention was a 30-minute lecture and teaching aids.	Students in intensive intervention group were significantly more likely ($p<0.001$) to have adopted high level of solar protection than standard intervention or control group.	Provides evidence for the effectiveness of an intensive, multi-event educational intervention in the school, in contrast to a single lecture-based intervention.
Loescher, 1995 ²² (U.S.A.)	RCT (moderate)	Hazard: UV radiation Target: children (4-5 yrs, 54 intervention, 68 control) Intervenor: researchers Setting: school Description: Intervention classrooms received a 'Be Sun Safe' curriculum, consisting of 3 50-min. activity-based learning modules.	Children in intervention group had significantly higher knowledge and comprehension scores ($p<0.05$) compared with controls, however, there was no difference in children's ability to apply their sun safety knowledge accurately.	Provides evidence for effectiveness of multi-session curriculum in improving sun safety knowledge and comprehension. At this stage of cognitive development, young children may not be able to apply their knowledge.

* Letters indicate the components of each study that were rated as 'weak' by the quality assessment process: [a] selection bias; [b] study design; [c] confounding; [d] blinding; [e] data collection; and [f] withdrawal.
 Abbreviations: ETS (environmental tobacco smoke); UV (ultraviolet); EMFs (electromagnetic fields).

designs (a weak study design prone to considerable bias) were commonly used to evaluate these interventions.

Quality assessment classified four studies as being of 'strong' and ten as being of 'moderate' quality. Most relevant studies (51/65) were methodologically weak and therefore were not considered further in this review. However, these studies are described elsewhere.²³ Studies of strong or moderate quality dealt primarily with UV radiation and environmental tobacco smoke (ETS). Thus there was a lack of evidence regarding other environmental hazards such as smog, contaminants in fish, pesticides and household toxics. Furthermore, although several studies evaluated important interventions such as media advisories or mass distribution of educational resources, these studies were

not included in the review due to their weak methodological quality.

Study outcomes

Table IV summarizes the interventions and outcomes of the 14 studies included in this review. Although some of the studies included a variety of intervention strategies (such as both counselling and provision of printed materials, or educational sessions and take-home print materials), the 14 studies were grouped into intervention categories based on the dominant intervention type. The number of studies by intervention category are: counselling (3); distribution of printed materials (2); educational session (3); mass campaign (3); and school curriculum (3).

Interventions were associated with positive changes in most outcome measures in

13 studies. However, in one study,¹⁵ the intervention was not associated with an improvement for most outcome measures. Table V summarizes the evidence on the effectiveness of the diverse interventions encountered in this review.

DISCUSSION

The results of this systematic review suggest that a number of health promotion interventions can be effective in increasing short-term public awareness and concern about environmental risks to health, specifically risks posed by ultraviolet radiation and environmental tobacco smoke. The results also provide mixed, but generally promising, support for the effectiveness of environmental awareness interventions in enhancing short-term, self-reported health-

protective behaviours. Of the thirteen studies that assessed behavioural outcomes, more than half (8/13) reported positive changes in protective behaviours.^{9-11,13,17-19,21} In general, the studies associated with positive behaviour changes used relatively intensive interventions in which there were multiple awareness events (such as with a series of educational activities during curriculum implementation) or multiple ways and settings in which the intervention was delivered (such as with a mass education campaign).

This systematic review cannot comment on the effectiveness of mass distribution of printed materials as nearly all evaluation studies (11/13) of this intervention type were of weak methodological quality. High-quality evaluation research is required to determine if common strategies such as tax bill inserts, or mass distribution of pamphlets, posters or factsheets to community locations or targeted mailing lists, are effective.

This review supports the position that mass education campaigns can be effective for enhancing public awareness and improving self-reported health-protective behaviours over the short term. The effectiveness of mass campaigns is not surprising since they tend to be comprised of multiple intervention types, and are of a scale, duration and intensity that is greater than single-component interventions. It is noteworthy, however, that the positive impacts of mass campaigns seem to attenuate over time. The time series designs used by Graham-Brown¹⁸ and Pehamberger¹⁹ are instructive in that they both demonstrate a return of outcome measures to pre-campaign levels about two years after the campaign stopped. Given this, there may be a need for repeated messaging over time.

This systematic review has some limitations that should be noted. It is likely that this review did not deal adequately with studies that examine the effectiveness of policy change or advocacy in promoting environmental awareness or risk reduction measures. Even though terms such as 'advocacy' and 'policy' were included in the search strategy, it is likely that these studies were screened out as 'not relevant'. While the relevance tool was quite appropriate for quantitative studies, the inclu-

TABLE V
Highlights of the Effectiveness of Diverse Interventions

- Mass education campaigns can be effective in enhancing ultraviolet radiation awareness and improving short-term health-protective behaviours.
- Curriculum-based interventions in schools can be effective in increasing awareness of ultraviolet radiation. Positive shifts in behaviour appear to occur when environmental messages are repeated in a variety of ways throughout a multi-week educational module.
- Counselling can be effective in enhancing self-reported health-protective behaviours (specifically for environmental tobacco smoke and dust mites) when augmented with additional strategies (such as computer-assisted instruction, skill development supports, self-monitoring assistance and extensive educational resources), however, minimal or 'usual care' counselling does not appear to be effective.
- Group educational sessions (lasting about an hour) can be effective in increasing short-term awareness of environmental hazards, but very short duration sessions do not appear to be effective. The impact of group sessions on behaviour appears to be minimal.
- There is some evidence that the provision of printed educational materials (alone) can increase short-term awareness of environmental hazards, but not shift actual behaviour.
- Evidence is not available on common interventions related to the mass distribution of printed materials (such as tax bill inserts, or mass distribution of pamphlets, posters or factsheets to community locations or targeted mailing lists) since nearly all evaluation studies on this intervention type were of 'weak' methodological quality.
- Evidence is not available from this review on the effectiveness of interventions related to policy, advocacy or involvement in networks or coalitions regarding environmental risks.

sion of a criterion for outcome measures likely excluded qualitative studies that might provide a more narrative assessment of policy or advocacy effectiveness. Although a validity assessment tool was available for the qualitative studies, the relevance screening process identified no qualitative studies.

Another limitation of the review is its broad scope. The review brings together a large variety of intervention types that have been applied to a wide range of environmental problems. Organization of information about the studies into categories resulted in a considerable amount of heterogeneity within the categories. It is quite possible that a particular intervention implemented in one setting, or with a specific target group, or regarding a specific environmental exposure, may not be effective in other circumstances. As an example, it may be easier to convince smoking parents of asthmatic children not to smoke in the home, than encourage them to use public transit (instead of their automobile) to commute to work. For other environmental hazards, such as radon in the United States, shifting behaviour towards increased radon testing has been very difficult, possibly due to the costs associated with testing and remediation. Shifting behaviours that have minimal cost impacts, such as applying sunscreen to young children or ensuring hand-washing to minimize exposure to pollutants in household dust, are likely easier to accomplish than more costly remedies.

It is unfortunate that this systematic review cannot offer a clearer picture of the effectiveness of interventions related to environmental hazards. The scope of the results of this review is limited by the range of hazards assessed, with the majority of relevant studies examining ultraviolet radiation and environmental tobacco smoke. Relatively few studies evaluated interventions concerning other common environmental issues, such as air quality (smog), pesticides, contaminants in sports fish, lead, water quality, household toxics or EMFs. The few studies that evaluated public awareness and risk reduction interventions associated with these environmental risks tended to be of weak methodological quality, and were therefore excluded from the review. Despite these limitations, this systematic review does suggest that many health promotion interventions applicable to public health practice for protecting the public from environmental risks can be effective. Even though there is direct evidence to suggest that these interventions can be effective for only a narrow range of environmental exposures, it is reasonable to consider applying these interventions to other environmental problems (e.g., smog, pesticide use reduction) and assessing their effectiveness in these situations.

Finally, there is a pressing need for more rigorous evaluation research on common interventions such as alerts, advisories, educational sessions, dissemination of educational materials, telephone counselling and media advocacy. These interventions

are attractive to health units because they are not as costly to implement as the more intensive interventions (such as mass campaigns) that this review found to be effective. There is also a need to expand evaluation techniques beyond randomized controlled trials (RCTs) since not all public awareness interventions are conducive to this evaluation type, particularly those that deal with media awareness, advocacy or policy-based activities.

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