



## REVIEW

# The effectiveness of distance-based interventions for smoking cessation and alcohol moderation among cancer survivors: A meta-analysis

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## Abstract

**Objective:** The objective of this study is to evaluate current evidence for the effectiveness of distance-based interventions to support smoking cessation (SC) or alcohol moderation (AM) among cancer survivors. Secondary, differences in effectiveness are explored regarding multibehaviour interventions versus single-behaviour interventions targeting SC or AM only.

**Methods:** A systematic search of PubMed, PsycINFO, Web of Science, EMBASE, CINAHL, and Cochrane Central Register of Controlled Trials was conducted. Intervention studies with and without control groups and randomized controlled trials were included. Random effects meta-analyses were conducted for the main outcomes: SC and AM rates at the follow-up closest to 6 months. Using subgroup analyses and meta-regression, effectiveness of single-behaviour versus multibehaviour interventions was evaluated.

**Results:** A total of 17 studies with 3796 participants; nine studies on SC only, eight studies on multibehaviour interventions including an SC or AM module, and no studies on AM only were included. All studies had at least some concerns regarding bias. Distance-based SC interventions led to higher cessation rates than control conditions (10 studies, odds ratio [OR] = 1.56; 95% CI, 1.13–2.15,  $P = .007$ ). Single-behaviour SC interventions reduced smoking rates compared with baseline (risk difference [RD] = 0.29; 95% CI, 0.19–0.39,  $P < .0001$ ), but multibehaviour interventions did not (RD = 0.13; 95% CI, –0.05 to 0.31,  $P = 0.15$ ). There was insufficient evidence that distance-based multibehaviour interventions reduced alcohol use compared with controls (three studies, standardized mean difference [SMD] = 0.12; 95% CI, –0.08 to 0.31,  $P = .24$ ).

**Conclusions:** Distance-based SC interventions are effective in supporting SC among cancer survivors. Single-behaviour SC interventions appear more effective than multibehaviour interventions. No evidence was found for the effectiveness of distance-based AM interventions for cancer survivors.

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**KEYWORDS**

alcohol, cancer, cancer survivors, effectiveness, interventions, meta-analysis, oncology, smoking cessation

**1 | BACKGROUND**

Alcohol and tobacco are classified as group I carcinogens,<sup>1,2</sup> and their use is one of the largest preventable risk factors for cancer occurrence.<sup>3</sup> Alcohol and tobacco use contribute to cancer recurrence and second cancers,<sup>4-6</sup> cancer mortality,<sup>7,8</sup> and iatrogenic effects of treatment.<sup>9</sup> Smoking and alcohol use contribute considerably to the total number of cancer cases.<sup>10,11</sup> Attributable cancer deaths in the United States are estimated at 28.8% and 4.0%, respectively.<sup>12,13</sup>

Smoking cessation (SC) and alcohol moderation (AM) are important for cancer survivors.<sup>14</sup> This is particularly true for patients with cancers known to be strongly associated with smoking or alcohol use (eg, lung, breast, colorectal, head, and neck cancer).<sup>3</sup> Nonetheless, rates of smoking and excessive alcohol use among cancer survivors are high.<sup>15-17</sup> One study among 50 000 US cancer survivors found that 16.1% smoked and 5.1% were heavy drinkers, rates similar to those for people without cancer (18.6% and 6.0%, respectively).<sup>18</sup>

Several psychological interventions to reduce alcohol and tobacco use among cancer survivors are available. These interventions are generally provided face to face or via telephone, and their effectiveness has been described in several reviews. One meta-analysis on SC interventions for all cancer survivors<sup>19</sup> was published in 2013, and a second one on SC counselling interventions for head and neck cancer survivors<sup>20</sup> in 2016. A narrative review without meta-analysis on both AM and SC interventions for head and neck cancer survivors<sup>21</sup> was published in 2018. Until now, no meta-analysis has been published on AM interventions for cancer survivors.

The two meta-analyses on SC interventions included randomized controlled trials (RCTs) and non-randomized studies. Nayan et al<sup>19</sup> reviewed 10 RCTs and three prospective cohort studies and found no evidence for the effectiveness of SC interventions compared with control groups after a mean follow-up time of 5 weeks (odds ratio [OR] = 1.54; 95% CI, 0.91-2.64, *P* = .108) and 6 months (OR = 1.31; 95% CI, 0.931-1.84, *P* = .120). However, SC interventions delivered in the perioperative period were found to be effective (OR = 2.31; 95% CI, 1.32-4.07), possibly because the preoperative period functions as a “teachable moment” associated with increased motivation to change unhealthy lifestyle behaviours. Klemp et al<sup>20</sup> reviewed SC interventions for head and neck cancer patients and found three RCTs, three cohort studies, and two case studies, concluding that counselling increased the cessation rate with 26% (relative risk [RR] = 0.76 favouring experimental condition; 95% CI, 0.59-0.97, *P* = .03).

One study<sup>21</sup> systematically reviewed RCTs on SC and AM interventions among head and neck cancer survivors and patients

with oral dysplasia, finding only three eligible RCTs and no RCT aimed solely at AM. Results on AM interventions among cancer survivors are clearly scarce, but reviews of studies among the general population are available. A systematic review comparing AM-guided and AM-unguided low-intensity Internet interventions found that participants used on average 22 g of ethanol less than controls.<sup>22</sup> A systematic review on brief AM interventions delivered in a primary care setting found similar results (mean difference of -20 g/wk; 95% CI, -28 to -12).<sup>23</sup> Assessment of incorporated behaviour change techniques (BCTs), theoretical underpinnings, and modes of delivery contributes to gaining further insight into factors possibly influencing effectiveness of SC and AM interventions.<sup>24</sup>

Health behaviour interventions can focus on changing a single behaviour<sup>25</sup> or multiple health behaviours simultaneously, sometimes referred to as multiple health behaviour change interventions.<sup>26</sup> Theoretically, multiple-behaviour interventions can have benefits over single-behaviour interventions because of greater real-world applicability and information provision on effective treatments for co-occurring behaviours, eg, alcohol and tobacco use.<sup>27</sup> However, a Cochrane review based on 12 RCTs concludes that multiple-behaviour rehabilitation interventions for cancer survivors might be less effective than single-behaviour interventions with regard to maintaining or improving physical and psychosocial well-being,<sup>28</sup> but this has not yet been evaluated for SC and AM specifically. In addition, improvement on all targeted behaviours of a multiple-behaviour intervention is scarce,<sup>29</sup> and cancer survivors are less likely to choose alcohol as the first behaviour to change.<sup>30</sup> Findings are mixed in non-cancer survivor populations receiving intensive substance use treatment for alcohol and smoking.<sup>31-33</sup>

The increasing population of cancer survivors<sup>34</sup> suggests an increased need for scalable evidence-based SC and AM interventions. Furthermore, self-management strategies have shown several beneficial effects in cancer survivors, including increase of self-efficacy.<sup>35</sup> Distance-based interventions (ie, telephone, print, or web based) offer autonomy and reassurance to cancer survivors<sup>36</sup> and may be effective and/or cost-effective.<sup>37,38</sup> A systematic review and meta-analysis of studies testing the effectiveness of distance-based SC and AM interventions for cancer survivors, which encourage SC and reduce alcohol intake, is lacking.

Therefore, in this systematic review and meta-analysis, we will address the following questions: (a) Do distance-based interventions increase SC rates and/or reduce alcohol use among cancer survivors? (b) Are single-behaviour interventions targeting SC or AM more effective than multibehaviour interventions including SC and/or AM modules?

## 2 | METHODS

### 2.1 | Search strategy

A systematic literature search of PubMed, PsycINFO, Web of Science, EMBASE, CINAHL, and Cochrane Central Register of Controlled Trials was conducted from inception to December 20, 2017, updated on November 8, 2018. The search string included a combination of synonyms for smoking, alcohol use, health behaviours, intervention, and cancer survivors (Appendix S1). Due to the expected paucity of literature and to optimally cover the available evidence, we included both RCTs and intervention studies with and without a control group. This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement<sup>39</sup> and was registered in the International Prospective Register of Systematic Reviews (PROSPERO identifier: CRD42017074567).

### 2.2 | Eligibility criteria

We included English peer-reviewed publications that evaluated the effectiveness of distance-based interventions aiming to reduce alcohol use and encourage SC or both, targeted cancer survivors, reported relevant outcomes, and were designed as an RCT or non-randomized study with or without control group. Interventions should be aimed at behaviour change of the individual. "Distance based" was operationalized as an intervention delivered at least 80% remotely and/or asynchronously, meaning that no more than 20% of total session time was delivered face to face or, in cases where information on session time was unavailable, no more than 20% of the total number of sessions. For example, interventions were included containing one-time face-to-face contact and continuation with several sessions by telephone or other remote-delivery modes. Cancer survivors are defined as those ever diagnosed with cancer, irrespective of treatment phase or life expectancy. Any participant who identifies as a smoker or had smoked in the past 7 days was considered a smoker. Anyone who had not smoked in the last 7 days or identifies as a non-smoker was considered a non-smoker. Anyone who drank alcohol in the past week was considered a drinker.

### 2.3 | Study selection and data extraction procedures

First, two researchers (A.M. and L.L.) independently screened titles and abstracts for eligibility and then read the full texts of potentially eligible articles. Disagreements were resolved through consensus meetings; when necessary, a third author (M.B.) was consulted. Reference lists of included papers were checked for additional eligible articles.

Extracted data from each article included title, author, year, country, participant characteristics, cancer site, study design, relevant outcome measures, effect sizes (number of smokers, number of non-smokers, non-responders, drinks per d/wk, standard deviation, and *P* values),

follow-up period, control group, and intervention characteristics. Delivery mode, guidance level, number of sessions, main intervention target, theoretical base, control group, relevant outcome measures, and reported BCTs according to Michie's taxonomy<sup>24</sup> were coded by two researchers (A.M. and L.L.). Study protocols or intervention development papers mentioned in the included papers were also checked, mainly to extract intervention characteristics and to assess risk of bias (RoB). Authors of the included studies were contacted in case of uncertainty regarding outcome data.

Studies reporting sufficient outcome details were included in the meta-analysis. The outcome assessment (closest to) 6 months after randomization was used in all analyses, as done in a previous similar review.<sup>20</sup>

### 2.4 | RoB and methodological quality assessment

Risk of bias was assessed at the outcome level using the Cochrane RoB tool 2.0 (RCTs),<sup>40</sup> ROBINS-I tool<sup>41</sup> (non-randomized studies with a control group [NR + CG]), and a standardized form for quality assessment of before and after studies without control group from the US National Heart, Lung and Blood Institute<sup>42</sup> (non-randomized studies without a control group [NR - CG]). Two authors (A.M. and J.B.) independently assessed RoB and reached consensus.

### 2.5 | Statistical methods

Random effects meta-analysis was conducted for SC and AM interventions separately. A pooled effect size was calculated between groups (intervention vs control, primary analysis) and within groups (before vs after intervention) where possible. For AM, mean number of drinks per week at baseline and follow-up was used to calculate Hedges' *g* (intervention vs control: between-group change) or SMC (standardized mean change, before vs after intervention: within-group change). For the AM within-group comparison, SMC was calculated with a conventionally assumed pretest/post-test correlation<sup>43</sup> of  $r = 0.70$  and following the Morris procedure.<sup>44</sup>

For SC studies, the numbers of smokers, non-smokers, and non-responders at baseline and follow-up were extracted, for both intervention and control groups. Non-responders were excluded from the analysis as some studies included non-smokers at baseline and baseline smoking status of the non-responders was not always clear; thus, the "missing-is-smoking" procedure could not be applied. Because this procedure is more common in SC research, sensitivity analyses applying this procedure to appropriate studies, resulting in intention-to-treat analyses, were carried out. For the SC within-group meta-analyses, risk differences (RDs) were reported; ORs were used as effect sizes when comparing intervention to control groups.

Heterogeneity was quantified in both AM and SC using the  $I^2$  statistic and tested for significance using the *Q* test. Using subgroup analyses and random effects meta-regression analysis with study as the random component, a possible source of heterogeneity, ie, dimensionality, was explored.<sup>45</sup> Publication bias was intended to be visually

evaluated by means of funnel plots, Egger's regression test, and the rank sum correlation test.

A two-sided *P* value of less than .05 was considered statistically significant. All statistical analyses were conducted in R software (version 3.5.1), with meta-analyses performed using the metafor package.<sup>46</sup>

### 3 | RESULTS

#### 3.1 | Study selection

The initial search strategy identified 6652 records, which included 2372 duplicates as identified by software programs Covidence<sup>47</sup> and Mendeley (version 1.19.2).<sup>48</sup> After abstract screening of the remaining 4280 records, 242 records were reviewed in full text. One additional study was identified through reference list searching of included studies. This yielded 17 studies for inclusion in the systematic review, of which 14 could be used for meta-analysis (Figure 1); one study did not provide sufficient outcome data for meta-analysis,<sup>49</sup> and two were secondary studies of the same trial,<sup>50</sup> describing an additional follow-up assessment<sup>51</sup> and process evaluation.<sup>52</sup>

#### 3.2 | Study characteristics

Most studies (76%, 13/17) were published between 2010 and 2018, the remainder being published between 2005 and 2009. Studies were carried out in the United States (76%, 13/17), two in Australia, one in The Netherlands, and one in the United Kingdom. Most studies were RCTs (71%, 12/17); four were NR - CG (23%), and one was NR + CG (6%). Two articles described secondary studies<sup>51,52</sup> of an already included trial<sup>50</sup>; as these reported the same sample of participants, they were excluded from the quantitative analyses. The remaining 15 studies included a total of 3796 participants, with a mean sample size of 253.1 (SD = 236.5) and a mean participant age of 52.8 (SD = 14.3) years; 58.6% were women (see Table 1).

#### 3.3 | Intervention characteristics

Fifteen unique interventions are described (Table S2). Most interventions were delivered by telephone (12/15),<sup>50,53,54,58-60,63,64,66-69</sup> often supplemented with printed materials (6/12)<sup>50,54,58-60,67</sup> and explicit encouragement of pharmacotherapy or nicotine replacement therapy (NRT) (8/12)<sup>50,53,54,63-67</sup>; three interventions involved face-to-face contacts in addition to remote delivery.<sup>54,65,66</sup> The remaining interventions were unguided web based (3/15),<sup>25,26,49</sup> with one explicitly encouraging use of pharmacotherapy or NRT.<sup>25</sup> Half of interventions targeted smoking only (7/15)<sup>25,50,53,63-66</sup>; one multiple-behaviour

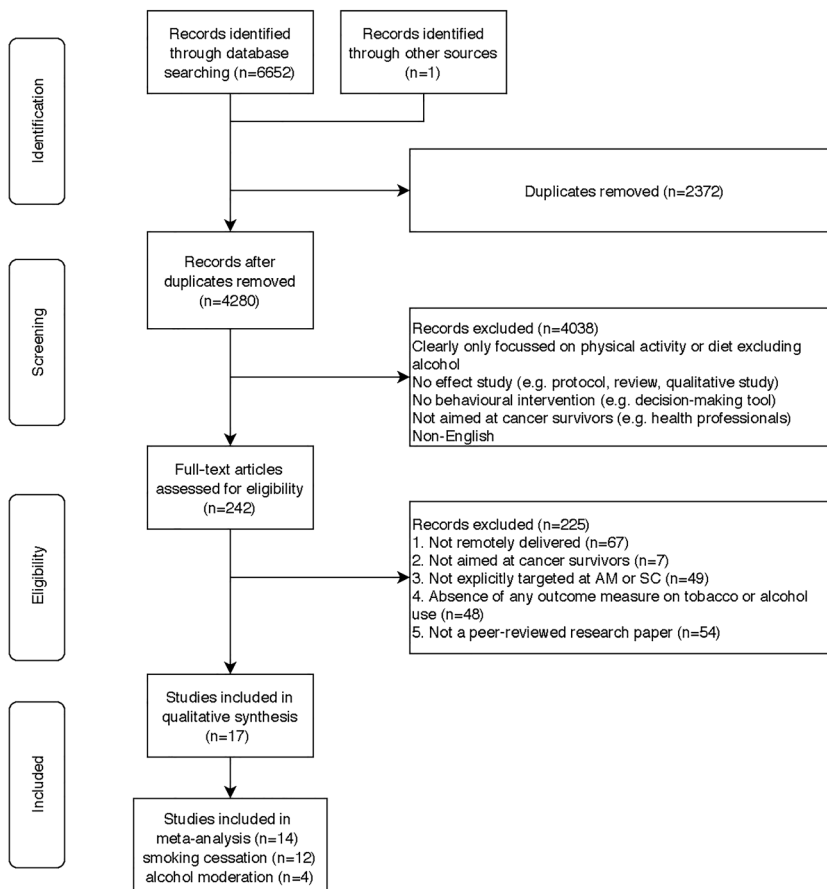


FIGURE 1 Study selection process

**TABLE 1** Study characteristics

Reference	Country	Sample Size, n	Age (Mean Years)	Gender (% Female)	Study Design	Control Group	Relevant Outcome Measures	Cancer Site
Amato et al <sup>53</sup>	USA	250	61.9	59.8	NR – CG	-	SC: 7	Thoracic
Berg et al <sup>49</sup>	USA	24	23.38	70.8	NR – CG	-	AM: 1, SC: 4	Lymphoma, leukaemia, osteosarcoma, thyroid, glioblastoma, Wilm's tumour
Duffy et al <sup>54</sup>	USA	184	57	16	RCT	Enhanced care as usual: face-to-face assessment and brief counselling, handout with resources, referrals	AM: 9, SC: 7	Head and neck
Emmons et al <sup>50</sup>	USA	796	31	47	RCT	Printed information brochure	SC: 7, 8	Leukaemia, CNS, lymphoma, kidney, neuroblastoma, soft tissue sarcoma, bone
Emmons et al <sup>51,a</sup>	USA	565	31	51.0	RCT	Printed information brochure	SC: 7, 8, 5	Leukaemia, CNS, lymphoma, kidney, neuroblastoma, soft tissue sarcoma, bone
Emmons et al <sup>25</sup> +protocol <sup>55</sup>	USA	374	32	49.7	RCT	Active: printed, tailored, and targeted self-help manuals, NRT/pharmacotherapy	SC: 5, 7, 8	Leukaemia, CNS, lymphoma, bone, other
Fazzino et al <sup>56</sup> +protocol <sup>57</sup>	USA	37	57.8	100	RCT	Active: biweekly information brochures	AM: 3	Breast
Grimmett et al <sup>58</sup>	UK	29	65	62	NR – CG	-	AM: 2	Colorectal
Hawkes et al <sup>59</sup>	Australia	20	66.0 (median)	50	NR – CG	-	AM: 1, SC: 4	Colorectal
Hawkes et al <sup>60</sup> +protocol <sup>61</sup>	Australia	410	66.4	46.1	RCT	Printed information brochure	AM: 2, 3 SC: 7	Colorectal
Kanera et al <sup>26</sup> +protocol <sup>62</sup>	The Netherlands	462	55.9	79.9	RCT	Waitlist	SC: 7	Breast (71%), other
Klesges et al <sup>63</sup>	USA	519	-	45.1	RCT	Active: participant-initiated telephone counselling and 2 weeks of NRT/ pharmacotherapy (compared with caregiver initiated and 4 wk of NRT)	SC: 6, 7, 8	NR
Klesges et al <sup>64</sup>	USA	427	-	67.0	RCT	Active: participant-initiated telephone counselling and 2 weeks of NRT/ pharmacotherapy (compared with caregiver initiated and 4 wk of NRT)	SC: 6, 7	NR
Ostroff et al <sup>65</sup>	USA	185	55.9	53	RCT	Active: counselling and NRT	SC: 5, 7	Thoracic, head and neck, breast, gynaecological, urology, other
Park et al <sup>52,b</sup>	USA	398	30.9	47.5	RCT	Printed information and manual on cessation	SC: 5, 7, 8	Leukaemia, CNS, lymphoma,

(Continues)

TABLE 1 (Continued)

Reference	Country	Sample Size, n	Age (Mean Years)	Gender (% Female)	Study Design	Control Group	Relevant Outcome Measures	Cancer Site
								kidney, neuroblastoma, soft tissue sarcoma, bone
Park et al <sup>66</sup>	USA	49	57.7	59.2	NR + CG study	Care as usual: not further specified	SC: 6, 7	Thoracic
Pollak et al <sup>67</sup>	USA	30	56.8	73	RCT (pilot)	Waitlist	SC: 5, 6, 7	Breast 33%, lung 20%, colon 10%, other

Note. 1 = days of drinking; 2 = number of drinks or grams of alcohol per week; 3 = number of drinks or grams of alcohol per day; 4 = days of smoking; 5 = cigarettes per day; 6 = smoking abstinence/smoking status biochemically verified; 7 = smoking abstinence/smoking status self-report; 8 = quit attempts; 9 = AUDIT.

Abbreviations: AM, alcohol moderation; CNS, central nervous system; NR, not reported; NR + CG, non-randomized with control group; NR - CG, non-randomized without control group; NRT, nicotine replacement therapy; RCT, randomized controlled trial; SC, smoking cessation.

<sup>a</sup>Describes additional follow-up to Emmons et al.<sup>50</sup>

<sup>b</sup>Secondary study on intervention participants of Emmons et al.<sup>50</sup>

intervention targeted smoking, alcohol use, and depression,<sup>54</sup> and one multiple-behaviour intervention targeted smoking and pain management.<sup>67</sup> None of the interventions targeted alcohol use solely. The remaining multiple-behaviour interventions targeted general lifestyle and health-related behaviours including diet and physical activity (6/15), of which four included an SC module<sup>26,49,59,60</sup> and six an AM module.<sup>26,49,58-60,68</sup> Reported theoretical/therapeutic underpinnings varied and included motivational interviewing (MI) (5/15),<sup>50,60,65-67</sup> cognitive behavioural therapy (CBT) (4/15),<sup>54,63,64,67</sup> and problem-solving therapy (3/15).<sup>26,60,68</sup>

### 3.4 | RoB within studies

At least some concerns regarding RoB were identified for all RCTs (Tables S3). RoB in selection of the reported result was high or with some concerns in all but one study,<sup>60</sup> as these studies did not refer to a published protocol paper with prespecified analyses. Bias due to missing outcome data was low in six studies,<sup>25,26,50,54,60,65</sup> indicating robustness of the outcomes against the impact of missing data. As the randomization process was often well described and (lack of) baseline imbalances well reported, no studies were at high RoB. Most studies elicited some concerns about bias due to deviations from intended interventions or bias in measurement of the outcomes (because blinding was not reported or absent). For detailed RoB and quality assessments of all studies, including NR - CG and NR + CG studies, see Table S3.

### 3.5 | SC and AM outcome measures

Smoking status or abstinence was assessed in most SC studies, except for Berg et al<sup>49</sup> who reported number of smoking days instead of smoking status. Hawkes et al<sup>59</sup> reported smoking status based on

smoking days, cigarettes per day, and age of commencing and quitting smoking. Self-reported smoking status was available in the 11 remaining SC studies, operationalized as 7-day point-prevalence abstinence,<sup>26,63,64,66,67,69,70</sup> 30-day point-prevalence abstinence,<sup>25</sup> 24-hour abstinence,<sup>53</sup> or unspecified duration of quit status.<sup>54,60</sup> In five studies, self-reported abstinence was verified with cotinine assessments.<sup>63,64,66,67</sup> Duration of follow-up differed from end of treatment (6 wk) to a maximum of 18 months. For SC meta-analyses, only one study could not be included as it reported number of smoking days but not number of smokers.<sup>49</sup>

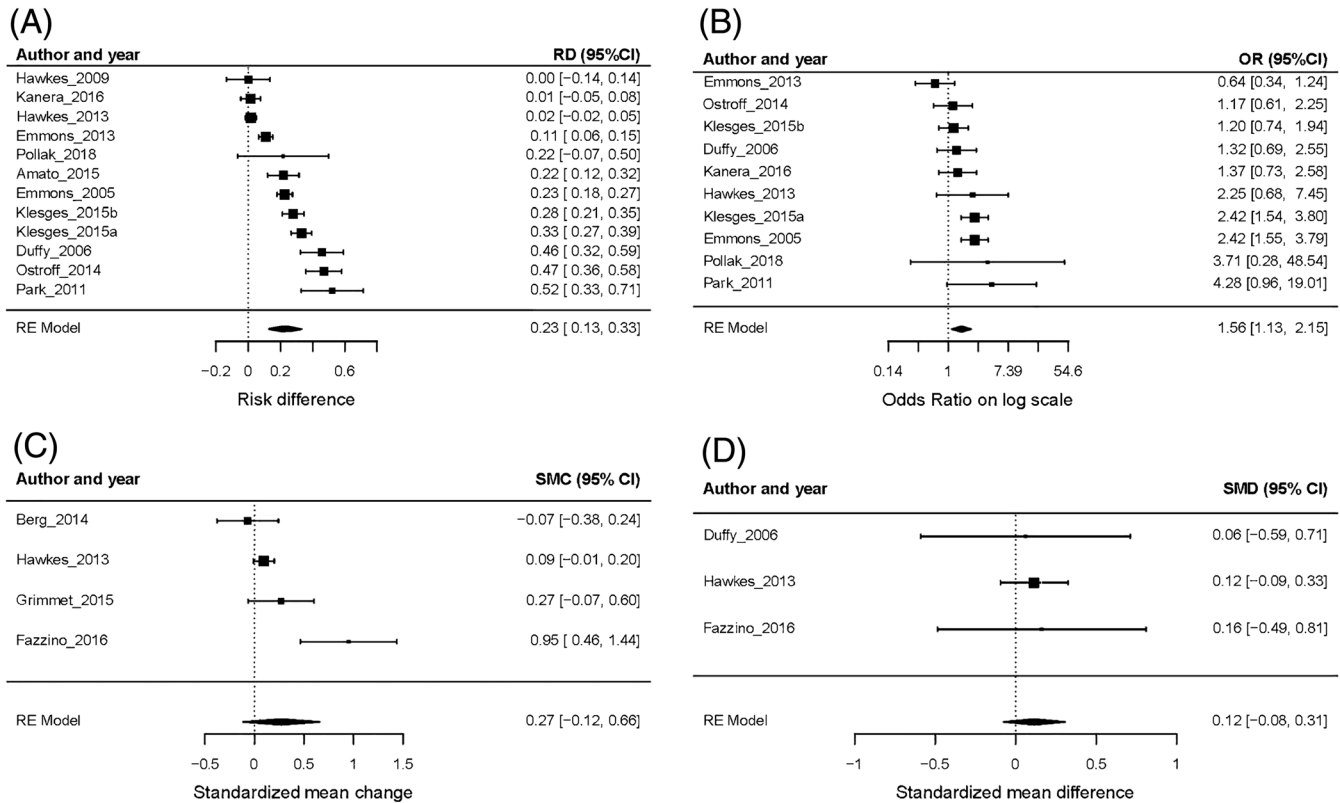
Assessment of alcohol use varied. Two studies measured mean alcohol use in grams per day,<sup>56,60</sup> the others measured drinking days in the past month,<sup>49</sup> alcohol units per week,<sup>58</sup> or AUDIT scores, a standard screening measure for alcohol problems.<sup>54</sup> Hawkes et al<sup>59</sup> classified participants in high-risk, low-risk, and non-drinker categories. For AM meta-analyses, two studies<sup>54,59</sup> could not be included, because no SMC could be calculated from the reported AUDIT scores and drinking days. See Table S4 for an overview of study outcomes.

### 3.6 | Effects on smoking

#### 3.6.1 | Within groups

On the basis of the within-group data (preintervention and postintervention) from 12 studies,<sup>25,26,50,53,54,59,60,63-67</sup> a pooled RD of 0.23 (95% CI, 0.13-0.33,  $P < .0001$ ) was found in favour of distance-based interventions (Figure 2). Mean follow-up time was 4.7 months (range 1.5-15, SD = 3.9). A high level of heterogeneity was observed ( $I^2 = 96.07%$ ,  $Q = 207.9$ ,  $P < .0001$ ). Results were similar when including RCTs only<sup>25,26,50,54,60,63,64,67,69</sup> (RD = 0.23; 95% CI, 0.12-0.34,  $P < .0001$ ;  $I^2 = 96.63%$ ,  $Q = 186.6$ ,  $P < .0001$ ).

Subgroup analyses were carried out on single-behaviour-focused interventions and multiple-behaviour interventions. Single-behaviour



**FIGURE 2** Forest plots of intervention effects. A, Intervention effect within groups: before and after intervention effect on smoking cessation rate. B, Intervention effect between groups: intervention and control group effect on smoking cessation rate. C, Intervention effect within groups: before and after intervention effect on alcohol moderation. D, Intervention effect between groups: intervention and control group effect on alcohol moderation

interventions<sup>25,50,53,63-66</sup> yielded a significant pooled RD of 0.29 (95% CI, 0.19-0.39,  $P < .0001$ ). After one outlier was excluded,<sup>25</sup> the pooled RD was 0.32 (95% CI, 0.23-0.41,  $P < .0001$ ), and heterogeneity between studies was reduced ( $I^2 = 86.42\%$ ,  $Q = 25.9$ ,  $P < .0001$ ). Multiple-behaviour interventions<sup>26,54,59,60,67</sup> produced a non-significant pooled RD of 0.13, and heterogeneity remained high (95% CI, -0.05 to 0.31,  $P = .15$ ;  $I^2 = 95.39\%$ ,  $Q = 41.9$ ,  $P < .0001$ ). After one outlier was excluded,<sup>54</sup> the pooled RD was 0.02 (95% CI, -0.01 to 0.05,  $P = .26$ ;  $I^2 = 0.11\%$ ,  $Q = 2.0$ ,  $P = .58$ ). A meta-regression also pointed towards a larger intervention effect for single-behaviour compared with multiple-behaviour interventions but failed to reach significance ( $B = 0.17$ ; 95% CI, -0.02 to 0.36,  $P = .08$ ).

### 3.6.2 | Between groups

Ten studies included a control group<sup>25,26,50,54,60,63-67</sup>, nine of which were RCTs. Overall smoking rates in intervention groups were lower than in control groups (OR = 1.56; 95% CI, 1.13-2.15,  $P = .007$ ;  $I^2 = 53.59\%$ ,  $Q = 19.2$ ,  $P = .02$ ). Mean follow-up time was 5.3 months (SD = 4.0). When excluding one non-randomized study,<sup>66</sup> the result did not change notably (OR = 1.50; 95% CI, 1.08-2.07,  $P = .01$ ;  $I^2 = 55.18\%$ ,  $Q = 17.5$ ,  $P = .03$ ).

Subgroup analyses showed similar ORs for single-behaviour intervention (OR = 1.56; 95% CI, 0.97-2.50,  $P = .06$ ;  $I^2 = 73.30\%$ ,  $Q = 17.9$ ,  $P < .01$ )<sup>25,50,63,64,66,69</sup> and multiple-behaviour intervention

(OR = 1.47; 95% CI, 0.97-2.24,  $P = .07$ ;  $I^2 = 0$ ,  $Q = 1.1$ ,  $P = .77$ ).<sup>26,54,60,67</sup> A meta-regression showed that no heterogeneity was explained by dimensionality ( $B = 0.04$ ; 95% CI, -0.72 to 0.80,  $P = .91$ ). No notable differences from the main within-group and between-group analyses were found in sensitivity analyses applying the “missing = smoking” procedure to appropriate studies.<sup>25,50,63,64,66,67,69</sup>

## 3.7 | Effects on alcohol use

### 3.7.1 | Within groups

Pooled SMC was not significant at<sup>27</sup> (95% CI, -0.12 to 0.66,  $P = .17$ ;  $I^2 = 87.15\%$ ,  $Q = 13.5$ ,  $P < .01$ ), based on within-group (preintervention and postintervention) analysis of four included studies.<sup>49,56,58,60</sup> All included AM interventions were multibehaviour focussed. Mean follow-up period was 7.5 months (SD = 7.1).

### 3.7.2 | Between groups

Three studies included a control group.<sup>54,56,60</sup> The pooled effect estimate was SMD = 0.12 (95% CI, -0.08 to 0.31,  $P = .24$ ;  $I^2 = 0\%$ ,  $Q = 0.05$ ,  $P = .98$ ) (Figure 2). Mean follow-up period was 10 months (SD = 6.9). All included AM interventions were multibehaviour focussed

### 3.8 | Risk of publication bias across studies

The number of studies involved in the between-group comparison meta-analyses was low for SC ( $n = 10$ ) and especially for AM ( $n = 3$ ). The initial funnel plot for SC does not show noteworthy deviations (see Figure S5), and Egger's test ( $P = .90$ ) and the rank correlation test ( $P = 1.0$ ) indicate that there is no statistical reason to assume a publication bias. No notable differences occur when only including RCTs ( $n = 9$ ). Publication bias for AM studies was not assessed as there were inadequate numbers of included trials to properly assess a funnel plot.

## 4 | DISCUSSION

On the basis of the synthesis of the evidence collected in our review, we conclude that distance-based SC interventions are effective in reducing tobacco use among cancer survivors. For AM, we found insufficient evidence that distance-based interventions are effective for cancer survivors. We also found evidence that single-behaviour-focussed SC interventions appear to be more effective than multiple-behaviour interventions based on within-group preintervention versus postintervention outcomes for SC. This difference between single- and multiple-behaviour interventions was not found in the meta-regression or between-group analyses, which are at lowest RoB. As we found no single-behaviour AM interventions, we could not assess a possible difference in effectiveness between single-behaviour and multiple-behaviour AM interventions.

The current findings match and extend the findings of earlier meta-analyses on SC interventions for cancer survivors.<sup>19,20</sup> SC interventions are more effective than control interventions, although one review only found an effect for interventions around the perioperative period<sup>71</sup>; this discrepancy might be explained by the inclusion of more recent studies in the current meta-analysis. We found no effect on AM, possibly due to the low number of reported AM studies for cancer survivors. Nonetheless, this review identified more studies on interventions targeting AM in cancer survivors than a previous review by Shingler et al,<sup>21</sup> which only included three RCTs. Previous reviews on AM interventions in the general population have been based on single-behaviour interventions aimed solely at AM,<sup>22,23</sup> while our review only included multiple-behaviour interventions. This could also explain the lack of evidence regarding the effectiveness of distance-based AM interventions.

Our within-group findings, suggesting that multiple-behaviour interventions are less effective than single-behaviour-focussed interventions, are based on subgroup analyses of single-behaviour and multibehaviour interventions comparing before and after SC rates. The meta-regression on before and after SC rates pointed in the same direction, although it failed to reach significance ( $B = 0.17$ ; 95% CI,  $-0.02$  to  $0.36$ ,  $P = .08$ ). Neither the subgroup analyses nor the meta-regression on between-group differences showed a difference in effectiveness for single-behaviour and multibehaviour interventions. These findings match evidence from a Cochrane review on

multidimensional rehabilitation programmes for cancer survivors.<sup>28</sup> Pollak et al<sup>67</sup> and Duffy et al<sup>54</sup> found a larger effect (RD =  $0.22$ ; 95% CI,  $-0.07$  to  $0.50$ , and RD =  $0.46$ ; 95% CI,  $0.32$ - $0.59$ , respectively) than the other multibehaviour studies but focussed on a limited number of behavioural targets (SC and pain management or SC, AM, and depression reduction), whereas the other multiple-behaviour interventions targeted lifestyle in a much broader sense.

A recent systematic review of alcohol interventions in older people based on individual patient data reported marked control group effects<sup>72</sup> and might partly explain the differing results in within- and between-group analyses for single-behaviour and multibehaviour SC interventions. Three studies that included a face-to-face component<sup>54,66,69</sup> show the greatest effect in the within-group analyses but not in the between-group analyses (see Figure 2), where this effect might have been moderated by the control group, diminishing the contrast.

The current review used a robust search strategy and is reported according to PRISMA guidelines. In order to optimally cover the available evidence on distance-based and scalable SC and AM interventions for cancer survivors, this review included studies on all cancer types, non-randomized studies (NR + CG and NR - CG), and multiple-behaviour studies with an AM or SC module. Results for RCTs are described separately when there were more than two RCTs to be pooled.

## 5 | CONCLUSIONS

Distance-based SC interventions can be effective in addressing SC in cancer survivors, although the amount and the quality of the evidence are suboptimal. Factors upon which effectiveness depends need to be further investigated. There are indications that single-behaviour-focussed SC interventions are more effective than multibehaviour interventions. We did not find sufficient evidence to draw firm conclusions on the effectiveness of distance-based AM interventions. More high quality studies are needed.

### 5.1 | Study limitations

The current findings should be considered in light of the study limitations. The number of studies included in the meta-analyses was low, particularly for AM, and statistical heterogeneity in both SC and AM studies was relatively high. This heterogeneity can be due to several factors: heterogeneity in modes of delivery, effect sizes, follow-up periods, and study designs. Use of RDs can also account for the very high heterogeneity in the within-group SC comparison, as these are absolute outcomes.<sup>45</sup> If included, control groups also varied considerably; several were handed printed information materials, while others were provided with active counselling and medication. In one study, control groups were waitlisted,<sup>26</sup> and in another, the control group condition was not further specified.<sup>66</sup> Bias could have been introduced as no information was available on correlation between preintervention and postintervention measures, and



therefore, a conventional pretest-post-test correlation of 0.70 was assumed. There was considerable loss of data in several studies due to non-response (Table S4), but applying the “missing = smoking” procedure for appropriate studies (not including non-smokers at baseline) did not yield different conclusions. Furthermore, for all outcome measures, there were at least some concerns about the RoB. Subgroup analyses covering cancer site, mode of delivery, or other potential moderators were not possible because of the low number of studies. Identified BCTs in the current systematic review (Table S2) are limited as intervention information was only extracted from published intervention descriptions.

## 5.2 | Clinical implications

The current review demonstrated that distance-based SC interventions are more effective in encouraging SC than controls. SC interventions differed in number of sessions, theoretical and therapeutic underpinnings, and level of guidance, suggesting that a diverse set of interventions can be effective and that tailoring the intervention according to the patient's wishes or caregiver's possibilities could be a positive feature. Considering the demonstrated possible superior effect of single-behaviour over multiple-behaviour interventions for SC, there is opportunity for further developing distance-based single-behaviour AM interventions for cancer survivors. Direct comparisons between multiple-behaviour and single-behaviour interventions in randomized trials are needed to be conclusive. Future work should also focus on conducting and reporting SC and AM trials among cancer survivors according to Consolidated Standards of Reporting Trials (CONSORT) statement guidelines in order to limit RoB and further explore possible moderators.

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## AUTHOR CONTRIBUTIONS

Ajla Mujcic drafted the manuscript, designed the study, performed study selection, data extraction, and risk of bias assessment, executed the meta-analysis, and read and approved the final manuscript. Matthijs Blankers drafted the manuscript, designed the study, aided in the meta-analysis, and read and approved the final manuscript. Jeroen Bommelé designed the study, performed risk of bias assessment and data extraction, made substantial contributions to the manuscript, and read and approved the final manuscript. Brigitte Boon designed the study, wrote, read, and approved the final manuscript. Rutger Engels designed the study, made substantial contributions to the manuscript, and read and approved the final manuscript. Irma Verdonck, Anne H. Berman, and

Margriet van Laar made substantial contributions to the manuscript and read and approved the final manuscript. All authors critically read earlier versions of the manuscript and approved the final manuscript.

## CONFLICT OF INTERESTS

A.M., M.B., M.v.L., B.B., and R.E. have been involved in the development and evaluation of single-behaviour alcohol and tobacco interventions for cancer survivors. Publications on these interventions have not been included in the current review. The authors declare that they have no other competing interests.

## DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analysed in this study.

## ETHICS APPROVAL

This manuscript describes a meta-analysis of published studies. For this type of study, no ethical approval is required.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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