Research Article

Cancer Epidemiology, Biomarkers & Prevention

Improving Cancer Preventive Behaviors: A Randomized Trial of Tailored Lifestyle Feedback in Colorectal Cancer Screening

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Abstract

Background: Cancer screening provides an opportunity to increase awareness of cancer-preventive lifestyle behaviors such as nonsmoking, physical activity, low alcohol consumption, and a healthy diet. We tested the effect of standardized, individually tailored written feedback (TF), and a standard leaflet (SL) on 1-year lifestyle behaviors in a colorectal cancer screening setting.

Methods: A total of 3,642 men and women aged 50–74 years invited to sigmoidoscopy screening were randomly assigned to: (i) TF; (ii) SL for cancer-preventive lifestyle behaviors; or (iii) control. Participants were mailed two self-reported lifestyle questionnaires (LSQ) 1 year apart. The TF intervention was based on the prescreening LSQ answers. We analyzed differences [with 95% confidence intervals (CI)] by comparing prescreening to 1-year follow-up of single cancer-preventive factors and the number of cancer-preventive lifestyle behaviors (range 0–4) between the groups by multivariable logistic regression and analysis of covariance (ANCOVA).

Results: A total of 1,054 screening participants without neoplastic findings (29% of those invited to screening) were included in this study. Participants in the TF group increased their number of cancer-preventive lifestyle behaviors significantly compared with those in the control group by 0.11 (95% CI, 0.02 to 0.19). Overweight/obese individuals in the TF group had a −0.84 kg (95% CI, −1.47 to −0.22) larger reduction in body weight compared with the control group.

Conclusions: TF at sigmoidoscopy screening led to small improvements in cancer-preventive behaviors.

Impact: Colorectal cancer screening is a suitable setting for increasing awareness of cancer-preventive behavior. *Cancer Epidemiol Biomarkers Prev; 27(12); 1442–9. ©2018 AACR.*

Introduction

The context of cancer screening provides an opportunity for a teachable moment to increase participants' awareness of cancer prevention with a healthy lifestyle (1). Cancer screening programs have not yet fully utilized this opportunity (2, 3). It is particularly important to increase lifestyle awareness at screening for cancers that are closely related to lifestyle such as colorectal neoplasia (4–7), as well as recurrent adenomas (8, 9). Raising awareness of the importance of a healthy lifestyle at colorectal cancer screening is also particularly relevant in light of evidence that colorectal cancer screening participation may reduce participants' motivation to make healthy lifestyle choices (10, 11).

An automatized written feedback letter delivered in a screening context would be a feasible low-cost strategy for increasing screening participants' awareness of their own lifestyle. Two separate British intervention studies within colorectal cancer screening programs have shown beneficial effects of individually tailored written advice on consumption of fruit and vegetables in screening participants in the short (6 weeks; ref. 12) and long term (6 months; ref. 13). Because only long-lasting beneficial lifestyle behaviors may impact chronic disease risk, such intervention effect should be investigated by an extended follow-up.

This study aimed to investigate the effect of (i) standardized, individually tailored written feedback (TF) and (ii) a standard leaflet (SL) for cancer-preventive lifestyle on 1-year follow-up of lifestyle behaviors in the context of colorectal cancer sigmoidoscopy screening.

Materials and Methods

Study design and participants

This study is a substudy within the Bowel Cancer Screening in Norway (BCSN) trial, a randomized trial piloting a national colorectal cancer screening program. The BCSN trial was carried out in two geographically defined areas in south-eastern Norway, Moss representing a more rural area and Bærum representing a more urban area. Men and women aged 50–74 years were included (14).

From November 2014 to September 2015, 3,642 individuals invited to sigmoidoscopy were additionally invited to complete a two-page lifestyle questionnaire (LSQ). We sent the questionnaire

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Note: Supplementary data for this article are available at Cancer Epidemiology, Biomarkers & Prevention Online (http://cebp.aacrjournals.org/).

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along with the screening invitation to be completed prior to the screening examination (prescreening LSQ). The individuals were randomized (1:1:1) at invitation based on the unique Norwegian social security number to one of the three groups: (i) TF; (ii) SL for cancer-preventive lifestyle; or (iii) control. A computer program carried out the randomization automatically. This randomization was blinded to the researchers and designed by the IT developer, following the consort guidelines (Supplementary Material S4). We mailed a second LSQ to the prescreening responders 12 months after the mailing of the prescreening LSQ. The outcome change in lifestyle was assessed by the follow-up LSQ. A paper version of the LSQ was included in the screening invitation letter. It was also possible to complete the LSQs in an online version available by personal login via a link provided in the invitation. No reminder was sent to nonresponders of the questionnaire.

LSQ

The LSQ consisted of questions used in previous national surveys (15, 16) and the Norwegian Colorectal Cancer Prevention study (11, 17). The participants were asked about demographic factors as well as lifestyle behaviors.

Demographic factors included ethnicity, dichotomized as native (Norway) or nonnative (any other country), marital status, dichotomized as married/cohabiting or nonmarried/non-cohabiting (or single), education length (primary school, high school, or a minimum of 2 years at university/college), and working status, dichotomized as working or not working (including retired, unemployed, homemakers, and disabled/on rehabilitation).

Height was assessed by whole centimeters and weight as whole kilograms.

The lifestyle behaviors included smoking status, dichotomized into current smokers (daily and occasional) and nonsmoker (former or never smokers). Physical activity (times/week of 30 minutes of activity) was calculated by adding the responses on frequency to the two questions on physical activity "without sweating or shortness of breath" and "with sweating or getting short of breath". Frequency ranged from "never" to "more than 7 times/week". Consumption of alcoholic beverages (glasses/week) was calculated by frequency of intake multiplied by the number of glasses usually consumed. Consumption of fruit, berries, and vegetables was calculated as a sum of reported consumption of (i) fruits and berries, (ii) raw vegetables, and (iii) boiled vegetables (portions/day). Consumption of red and processed meat for dinner was calculated as a sum of reported frequency consumption of (i) steak, pork chops, or similar, (ii) hamburgers or other dishes with minced meat, and (iii) sausages (portions/week). Six frequency alternatives ranging from "seldom/never" to "more than three portions/day" were provided as response options for the dietary questions.

On the basis of the following factors: smoking habits, physical activity, and consumption of alcoholic beverages, fruit, berries, and vegetables, we created a scale for the number of cancer preventive lifestyle behaviors (Table 1). The number of cancer preventive lifestyle behaviors ranged from zero to four. Each of the single lifestyle factors was dichotomized to reflect adherence to health recommendations (18–20). Change in weight was used as a separate outcome and not included in the scale for number of cancer preventive lifestyle behaviors. Body mass index (BMI, kg/m^2) was calculated to identify individuals who were not following the health recommendations on weight ($\geq$25 kg/m^2).

Table 1. Number of cancer preventive lifestyle behaviors and cutoff for each cancer preventive behavior

	Prescreening	Follow-up
Smoking		
Nonsmoking	1	1
Smoking	0	0
Physical activity		
$\geq$30 minutes times/week	1	1
<30 minutes times/week	0	0
Alcoholic beverages, mean glasses/week		
$\leq$14 for ♂, $\leq$7 for ♀)	1	1
>14 for ♂, >7 for ♀)	0	0
Fruits and vegetables, mean portions/day		
$\geq$5 a day	1	1
<5 a day	0	0
Number of cancer preventive lifestyle behaviors	1–4	1–4

Intervention

The control group did not receive any intervention or information on colorectal cancer prevention.

One to 4 weeks after completion of the prescreening LSQ, responders in the SL group received the Norwegian Cancer Society's one-page leaflet, "Good habits for a healthier life" with lifestyle advice for low cancer risk (Supplementary Material S1) by mail. The leaflet was mailed either before or after the screening examination.

Similarly, 1–4 weeks after completion of the prescreening LSQ, responders in the TF group received a 2 to 3 page letter by mail from the research team with a TF letter based on their answers to the prescreening LSQ. The letter addressed five lifestyle factors; smoking, consumption of alcoholic beverages, consumption of fruit, berries, and vegetables, physical activity, and body weight. The behaviors reported by the participant were compared with health recommendations. The participant was praised if they met the recommendations. If the reported behaviors did not meet the recommendations, the individual was encouraged to change their behavior to meet the recommended levels. This could be; "You answered that you rarely or never eat fruit, berries, and vegetables. This is less than recommended. The recommendation is to eat at least five servings/day. One serving is approximately 100 g. This equals for example, a small bowl of salad, a carrot, or a medium sized fruit". All participants in the TF group also received the Norwegian Cancer Society's one-page leaflet (Supplementary Material S1 and S2). Subjects in both the TF and SL groups who reported current smoking additionally received the Norwegian Cancer Society's leaflet "Stop smoking without gaining weight" (Supplementary Material S3).

Screening

The sigmoidoscopy screening result was defined as positive if one of the following was detected or suspected: (i) any polyp $\geq$ 10 mm in diameter, (ii) any adenoma with villous histology or high-grade dysplasia, (iii) $\geq$3 adenomas, or (iv) cancer. Participants with a positive screening were referred to a follow-up colonoscopy. The final screening result in this study was one of the following: (i) negative screening, (ii) other findings, or (iii) neoplasia on the basis of sigmoidoscopy and colonoscopy.

Exclusion criteria

Participants were excluded from screening due to medical reasons (e.g., severe heart, lung, or liver diseases, cancer with life expectancy less than 1 year), previous colorectal cancer, relocating

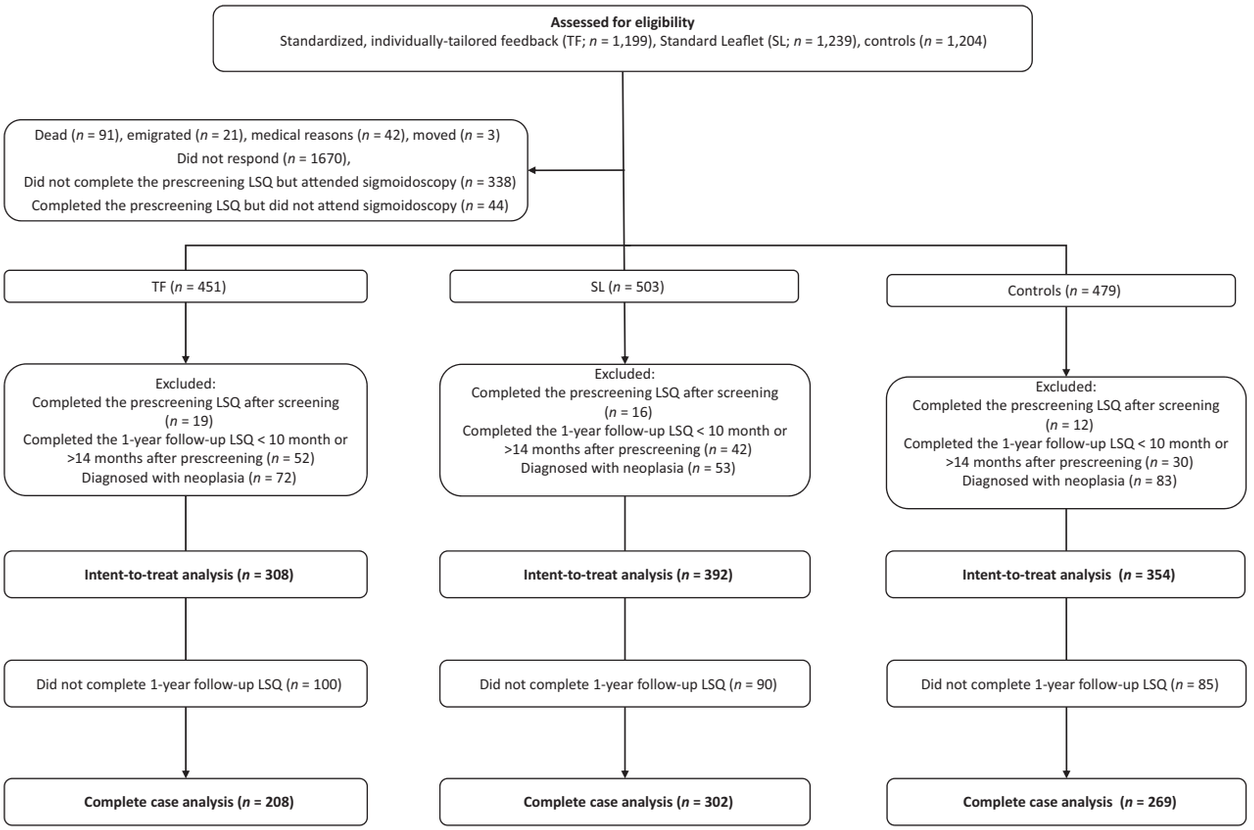

Figure 1.

Recruitment of participants, randomization, and follow-up in the randomized controlled trial on lifestyle intervention in the Bowel Cancer Screening in Norway pilot study. CONSORT Flow diagram showing procedures of selection among eligible individuals and participants with complete data available.

out of the screening municipalities, or previous colonoscopy in the last 12 months. Furthermore, participants were excluded from this study if not completing the prescreening LSQ or if the completion date was not possible to determine. Participants who completed the prescreening LSQ after the screening examination, or who completed the 1-year follow-up LSQ <10 or >14 months after prescreening LSQ were also excluded. Individuals with any adenomas or cancer findings at screening were excluded from this study (Fig. 1) to minimize potential bias of lifestyle change caused by being diagnosed with adenomas or colorectal cancer. This adds comparability between the current and earlier studies, for example, Robb and colleagues (2010).

Statistical analyses

We used *t* tests to evaluate the changes in lifestyle between prescreening and 1-year follow-up within each group. McNemar test was used similarly for changes in smoking status. When examining differences in changes in lifestyle variables between the intervention groups and the control group at follow-up, we used an analysis of covariance for the continuous variables, and a multivariable logistic regression model for smoking. The 95% CI was also calculated. The statistical models were adjusted for sex, age at invitation, education length, working status, ethnicity, marital status, screening center (Moss or Bærum Hospital), and time between completion of prescreening and follow-up questionnaires. The models were additionally adjusted for the prescreening value of the examined variable and prescreening values for weight, and the lifestyle variables; smoking status, level of physical activity, consumption of alcoholic beverages, fruit and vegetables, red and processed meat, and fish. Self-reported chronic disease was not included in the final model, because the preliminary models adjusting for this variable did not differ from the presented results. We conducted analyses stratified by gender. We also compared change in lifestyle between the TF and SL groups. Furthermore, we completed statistical analyses including only individuals who did not adhere to single health recommendations or who had a number of cancer preventive lifestyle behaviors ≤ 2 at prescreening.

Sample size estimates. We based the power calculation on predicted difference in self-reported 1 year change in intake of fruit, berries, and vegetables between the TF and the control group, which we expected to be 0.26 (SD 1.53) portions/day (80% power, $P = 0.05$; ref. 21). We estimated 540 subjects in each of the three groups to be an adequate number for analyses. We invited 3,642 subjects to participate.

The primary analyses were based on intention-to-treat, where if missing the 1-year follow-up LSQ, the values in the prescreening LSQ were carried forward. Similarly, if answered the 1-year follow-up LSQ but values were missing, the baseline values were carried

Table 2. Demographic characteristics

	TF ($n = 308$)	SL ($n = 392$)	Controls ($n = 354$)
Age			
Mean (SD), years	64.1 (6.9)	64.9 (7.0)	63.8 (6.8)
Time between sigmoidoscopy and 1-year follow-up LSQ			
Mean (SD), days	345.6 (29.4)	341.4 (25.6)	346.6 (33.9)
Sex (%)			
Female	53	50	52
Center (%)			
Moss	72	39	74
Bærum	28	61	26
Working status (%)[a]			
Working	48	47	49
Not working	48	49	49
Marital status (%)[a]			
Nonmarried/non-cohabiting (or single)	19	20	18
Married/cohabiting	79	77	80
Education length (%)[a]			
Primary school	18	12	16
High school	39	39	43
University/≥2 years at college	41	46	37
Ethnicity (%)[a]			
Norwegian	92	92	95
Not Norwegian	5	7	3

NOTE: A randomized trial of tailored lifestyle feedback in a sub study of the sigmoidoscopy arm of the bowel cancer screening in Norway: a pilot study. $N = 1{,}054$ (intention-to-treat analyses), who answered the lifestyle questionnaire at prescreening before sigmoidoscopy and without neoplasia.
[a]The percent might not add up to 100% due to missing data.

forward. Secondary analyses were based on complete case analyses, meaning that individuals with missing 1-year follow-up LSQ or missing values in one or several variables were excluded from the analyses.

The analyses were carried out using STATA software, version 14.1 (Stata Corp.).

Ethics

The Regional Ethics Committee of South-East Norway approved the study protocol (approval no. 2011/1272; trial registration: http://www.clinicaltrials.gov, identifier: NCT 03396029, retrospectively registered January 10, 2018). Approved by the ethical committee, the participants gave their written informed consent to participate by returning the questionnaire.

Results

Overall, 3,642 individuals were invited, and 1,433 (39%) participated in sigmoidoscopy screening and completed the prescreening LSQ. Of these, 1,054 (75%) completed the prescreening LSQ before the screening and had no neoplastic findings: 308 in the TF, 392 in the SL, and 354 in the control group (Fig. 1). These were used for the primary analyses based on intention-to-treat.

The demographic characteristics of the three groups at prescreening are shown in Table 2. More individuals in the SL group had a high-level education compared with the TF and control group.

Table 3 shows lifestyle characteristics at prescreening and 1-year changes in the TF, SL, and control groups and adjusted differences in lifestyle changes during follow-up. There were no differences in lifestyle factors at prescreening between the groups. Individuals in the SL group reduced their alcohol consumption significantly by −0.54 glasses/week (95% CI, −0.94 to −0.14) compared with the control group. Individuals in the TF group increased their number of cancer-preventive lifestyle behaviors significantly by 0.11 (95% CI, 0.02 to 0.19) compared with the control group (Table 3). Analyses stratified by gender showed that only men in the SL group significantly decreased their consumption of alcoholic beverages compared with controls −0.91 glasses/week, (95% CI, −1.56 to −0.26). Women in the TF group significantly increased their physical activity by 0.51 times/week (95% CI, 0.05 to 1.98) compared with controls. Only men in the SL group significantly increased their number of cancer-preventive lifestyle behaviors by 0.13 (95% CI, 0.01 to 0.24) compared with controls (Supplementary Material S5; Table 1).

Lifestyle characteristics and 1-year changes for individuals who did not adhere to single health recommendations and those with a number of cancer-preventive lifestyle behavior ≤ 2 at prescreening are shown in Table 4. Among participants with a BMI ≥ 25 kg/m^2, individuals in the TF group reduced their weight significantly by −0.84 kg (95% CI, −1.47 to −0.22) compared with the controls at 1-year follow-up. In the SL group, participants with alcohol consumption higher than recommended had a significant decrease in consumption by −4.98 glasses/week (95% CI, −7.83 to −2.13) compared with the controls at 1-year follow-up (Table 4).

When comparing the TF with the SL group, a significantly higher increase in fruit and vegetable intake was observed in the TF group [0.18 portions/day (95% CI, 0.01 to 0.34); Supplementary Material S5; Table 2].

The proportion of nonresponders to the 1-year follow-up LSQ differed between the three groups, being 100 of 308 (32%) in the TF, 90 of 392 (22%) in the SL, and 85 of 354 (24%) in the control group (Fig. 1). Nonresponders to the follow-up LSQ were younger (mean age 62.8, 63.9, and 62.8 years) compared with the responders (mean age 65.9, 65.2, and 64.7 years) in the TF, SL, and control groups, respectively. Prescreening lifestyle variables and screening result did not differ between the follow-up LSQ responders and nonresponders. The secondary results by complete case analyses, based on the 779 participants who completed both the prescreening LSQ and the 1-year follow-up LSQ showed similar

Table 3. Changes in cancer preventive factors.

	TF ($n = 308$)	SL ($n = 392$)	Control ($n = 354$)
Nonsmoker (%)			
Prescreening	83.4	87.5	83.3
1-year follow up	86.6	88.5	86.8
Change[a]	ns	ns	ns
Adjusted 1-year outcome compared with the controls, odds ratio (95% CI)	2.38 (0.56 to 10.2)	1.85 (0.41 to 8.28)	1.00 (ref)
Weight, mean (kg)			
Prescreening (SD)	79.6 (14.7)	78.7 (14.9)	80.8 (15.1)
1-year follow-up, (SD)	79.6 (14.8)	78.6 (15.0)	80.8 (15.2)
Change (95% CI)	−0.08 (−0.37 to 0.22)	−0.03 (−0.28 to 0.22)	0.17(−0.07 to 0.41)
Adjusted 1-year outcome compared with the controls (95% CI)	−0.27 (−0.73 to 0.19)	−0.39 (−0.83 to 0.06)	(ref)
Physical activity, mean 30 minutes times/week			
Prescreening (SD)	4.2 (2.8)	4.7 (3.0)	4.1 (2.9)
1-year follow-up, (SD)	4.2 (2.7)	4.7 (3.0)	4.0 (2.8)
Change (95% CI)	−0.01 (−0.22 to 0.21)	−0.06 (−0.27 to 0.14)	−0.05 (−0.26 to 0.16)
Adjusted 1-year outcome compared with the controls (95% CI)	0.14 (−0.19 to 0.48)	0.04 (−0.29 to 0.37)	(ref)
Alcoholic beverages, mean glasses/week			
Prescreening (SD)	4.2 (15.4)	4.4 (9.1)	3.8 (5.0)
1-year follow-up (SD)	4.4 (15.6)	4.0 (5.7)	4.0 (5.2)
Change (95% CI)	0.23 (−0.12 to 0.57)	−0.41 (−1.18 to 0.35)	0.18 (−0.09 to 0.44)
Adjusted 1-year outcome compared with the controls (95% CI)	−0.27 (−0.68 to 0.14)	−0.54 (−0.94 to −0.14)	(ref)
Fruits and vegetables, mean portions/day			
Prescreening (SD)	2.3 (1.3)	2.3 (1.3)	2.2 (1.4)
1-year follow-up (SD)	2.4 (1.5)	2.3 (1.3)	2.2 (1.4)
Change (95% CI)	0.11 (0.00 to 0.23)	−0.04 (−0.12 to 0.05)	0.02 (−0.11 to −0.14)
Adjusted 1-year outcome compared with the controls (95% CI)	0.12 (−0.05 to 0.28)	−0.01 (−0.16 to 0.15)	(ref)
[b]Number of cancer preventive lifestyle behaviors, mean number			
Prescreening (SD)	2.0 (0.7)	2.1 (0.7)	2.0 (0.7)
1-year follow-up (SD)	2.1 (0.7)	2.1 (0.6)	2.0 (0.7)
Change (95% CI)	0.02 (−0.04 to 0.09)	−0.03 (−0.08 to 0.03)	−0.04 (−0.10 to 0.02)
Adjusted 1-year outcome compared with the controls (95% CI)	0.11 (0.02 to 0.19)	0.06 (−0.02 to 0.14)	(ref)

NOTE: A randomized trial of tailored lifestyle feedback in a sub study of the sigmoidoscopy arm of the bowel cancer screening in Norway: a pilot study. $N = 1{,}054$ (Intention-to-treat analyses).In the adjusted models, differences in change of lifestyle between TF versus control and SL versus control were tested. A logistic regression model was used for smoking and ANCOVA for the other lifestyle variables. The adjusted models were controlled for age, sex, screening center, ethnicity, marital status, working status, education length, prescreening weight, and prescreening value of the dependent variable along with prescreening value of the other lifestyle variables. Paired *t* test was used to test mean changes and 95% CI.

Abbreviation: ns, nonsignificant.

[a]McNemar test was used to test for changes in smoking status, within the groups (TF, SL, and control). Intention-to-treat analyses were used.

[b]The number of cancer preventive lifestyle behaviors were adjusted for age, sex, screening center, ethnicity, working status, education length, prescreening weight, and the prescreening number of cancer preventive lifestyle behaviors.

trends as the primary intention-to-treat analyses. The improvement in the number of cancer-preventive lifestyle behaviors was some larger in the complete case analyses than in the intention-to-treat analyses (Supplementary Material S5; Tables 3 and 4). The improvement in fruit and vegetables intake in the TF compared with the control group was significant only in the complete case analyses.

Discussion

In this randomized trial in a colorectal cancer screening setting, we found that TF led to small improvements at 1-year follow-up for cancer-preventive behaviors among participants with no neoplastic findings. There was a low overall questionnaire response rate at prescreening (39%). The nonresponse rate to the 1-year follow-up LSQ was higher in the TF group (32%) compared with the SL (22%), and control (24%) groups. However, similar trends were observed for the intention-to-treat analyses (including nonresponders to 1-year follow-up LSQ) and complete-case analyses (excluding nonresponders to 1-year follow-up LSQ).

To the best of our knowledge, this is the first letter-based lifestyle intervention study with follow-up time longer than 6 months in a population-based colorectal cancer screening context. The few studies on lifestyle intervention in a colorectal cancer screening setting have suggested that an individually tailored approach is more effective than delivery of standard leaflets (12, 13, 22, 23). This has been observed as increased consumption of fruit and vegetables in both short (6 weeks; ref. 12) and long-term (6 months; ref. 13). The short-term trial (6 weeks) intervened on fruit and vegetable intake only. That study differed from this study by including individuals who voluntarily signed up to receive more information about healthy diet (12), while this study included a random sample of sigmoidoscopy invitees. The 6-month follow-up trial (13) showed that the individually tailored intervention had an effect on fruit and vegetable consumption similar to our study. An intervention trial including only individuals diagnosed with colorectal adenomas at colorectal cancer screening found personalized advice letters and face-to-face contact to increase fiber intake after 3 months (23). Also in a nonscreening setting, 8 months of telephone counseling and a tailored letter intervention after removal of adenomatous polyps increased physical activity level, reduced intake of red meat, and increased an overall score on lifestyle (22). These studies may indicate a higher success of lifestyle interventions in high-risk individuals

Table 4. Changes in cancer preventive factors for individuals who did not adhere to health recommendations at prescreening

	TF	SL	Controls
Smokers prescreening, *N* = 156	*n* = 51	*n* = 49	*n* = 56
Nonsmokers prescreening, n	0	0	0
Nonsmokers, 1-year follow-up, n	7	4	6
Change	*P* = 0.02	*P* = 0.13	*P* = 0.03
Adjusted 1-year outcome compared with the controls, by logistic regression, odds ratio (95%CI)	2.33 (0.31 to 17.5)	0.50 (0.03 to 7.55)	1.00 (ref)
Weight, mean (kg), *N* = 620	*n* = 178	*n* = 217	*n* = 225
Prescreening (SD)	87.5 (12.6)	87.0 (12.1)	88.0 (12.5)
1-year follow-up (SD)	87.1 (12.8)	86.9 (12.5)	88.1 (12.6)
Change	−0.40 (−0.85 to 0.04)	−0.14 (−0.51 to 0.23)	0.12 (−0.17 to 0.40)
Adjusted 1-year outcome compared with the controls (95% CI)	−0.84 (−1.47 to −0.22)	−0.61 (−1.22 to 0.00)	(ref)
Physical activity, mean 30 minutes times/week, *N* = 743	*n* = 229	*n* = 257	*n* = 257
Prescreening (SD)	3.1 (1.7)	3.2 (1.6)	2.8 (1.7)
1-year follow-up (SD)	3.5 (2.3)	3.5 (2.2)	3.2 (2.2)
Change	0.38 (0.17 to 0.59)	0.32 (0.10 to 0.54)	0.38 (0.19 to 0.58)
Adjusted 1-year outcome compared with the controls (95% CI)	0.03 (−0.33 to 0.39)	−0.11 (−0.47 to 0.25)	(ref)
Alcoholic beverages, mean glasses/week, *N* = 77	*n* = 22	*n* = 29	*n* = 26
Prescreening (SD)	11.8 (3.9)	12.7 (5.2)	15.9 (7.8)
1-year follow-up (SD)	10.3 (4.3)	9.5 (5.2)	15.6 (8.5)
Change	−1.52 (−3.44 to 0.40)	−3.20 (−5.40 to −1.00)	−0.27 (−1.29 to 0.75)
Adjusted 1-year outcome compared with the controls (95% CI)	−0.83 (−3.82 to 2.16)	−4.98 (−7.83 to −2.13)	(ref)
Fruits and vegetables, mean portions/day, *N* = 941	*n* = 275	*n* = 350	*n* = 316
prescreening (SD)	2.2 (1.1)	2.2 (1.1)	2.1 (1.1)
1-year follow-up (SD)	2.3 (1.4)	2.2 (1.1)	2.2 (1.3)
Change	0.13 (0.02 to 0.25)	0.00 (−0.08 to 0.08)	0.08 (−0.03 to 0.19)
Adjusted 1-year outcome compared with the controls (95% CI)	0.12 (−0.04 to 0.28)	−0.01 (−0.16 to 0.15)	(ref)
Number of cancer preventive lifestyle behaviors ≤ 2, mean[a] *N* = 641	*n* = 192	*n* = 235	*n* = 214
Prescreening (SD)	1.8 (0.4)	1.8 (0.4)	1.7 (0.5)
1-year follow-up (SD)	1.9 (0.5)	1.9 (0.5)	1.8 (0.6)
Change	0.11 (0.05 to 0.17)	0.09 (0.03 to 0.15)	0.08 (0.02 to 0.13)
Adjusted 1-year outcome compared with the controls (95% CI)	0.08 (−0.00 to 0.17)	0.03 (−0.06 to 0.11)	(ref)

NOTE: A randomized trial of tailored lifestyle feedback in a sub study of the sigmoidoscopy arm of the bowel cancer screening in Norway: a pilot study. Paired *t* test was used to test mean changes and 95% CI. McNemar test was used to test for changes in smoking status, within the groups (TF, SL, and control), Intention-to-treat analyses were used. In the adjusted models, differences in change of lifestyle between TF versus control and SL versus control were tested. A logistic regression model was used for smoking and ANCOVA for the other lifestyle variables. The adjusted models were controlled for age, sex, screening center, ethnicity, marital status, working status, education length, prescreening value of the dependent variable, and prescreening weight along with prescreening value of the other lifestyle variables.

Abbreviation: ns, nonsignificant.

[a]The number of cancer lifestyle preventive behaviors were adjusted for age, sex, screening center, ethnicity, working status, education length, prescreening weight, and the prescreening number of cancer preventive lifestyle behaviors.

compared with our population, as suggested earlier (24), although the interventions used were also more intense (face-to-face contact, telephone counseling) than this study.

Some limitations have to be acknowledged in interpreting the current results. We did not have information about the participants' prestudy awareness of lifestyle recommendations or their knowledge of the association between lifestyle and risk of colorectal cancer at prescreening. However, this might be a minor problem, as previous studies have not observed any effect of awareness of lifestyle recommendations on change in lifestyle (13). Attitudes to lifestyle change were not assessed in this study and could be a confounding variable. The findings are only generalizable to those attending colorectal cancer screening and completing a LSQ. People attending cancer screening willing to complete questionnaires might be more motivated toward cancer-preventive behavior or lifestyle changes than the general population and nonparticipants. The sample size was smaller than estimated by the power calculations, which resulted in the study being underpowered. We were unable to analyze the independent effect of the TF without the SL for cancer-preventive lifestyle, because these were both sent to the TF and SL group. Furthermore, chance findings cannot be ruled out as a large number of statistical tests were carried out. The results should be interpreted with caution and as indicative findings that should be tested in a fully powered trial.

The strength of this study was the relatively long-term follow-up period. The intervention with a multiple risk factor approach may be more effective on overall lifestyle change compared with an approach with one or two individual lifestyle factors (25, 26). Furthermore, being a population-based randomized trial increases the generalizability of the results to population-based screening programs.

A minimal intervention such as the TF or SL in this study might not be adequate to enhance lifestyle behaviors or reinforce motivation to change lifestyle behaviors over time. However, it may increase awareness of the importance of lifestyle behavior to lower colorectal cancer risk when delivered at colorectal cancer screening (27). To have an impact on population health, the lifestyle improvement has to be long lasting. To date, there are no intervention trials with longer than 1-year follow-up within colorectal cancer screening. Future trials should therefore test the effect of repeated reminders of lifestyle recommendations on lifestyle behavior, for example, by SL or a smartphone app. Furthermore, it should be investigated whether intervention

materials should be tailored to gender and educational level. A previous Norwegian study showed that colorectal cancer screening increased the occurrences of lifestyle-related diseases among individuals with low educational levels but not for people with higher levels of education (28). This study indicates that the effect of giving a leaflet on healthy behaviors at colorectal cancer screening may be almost as effective as TF in promoting favorable lifestyle changes. Future studies are necessary to separate the impact of individual and general feedback.

Conclusion

A low-cost, minimal intervention using TF and a SL for cancer-preventive behaviors given in a colorectal cancer screening context led to small improvement in cancer-preventive behaviors. The intervention appeared to be most effective in overweight individuals.

Disclosure of Potential Conflicts of Interest

G. Hoff has received speakers bureau honoraria from Amgen. No potential conflicts of interest were disclosed by the other authors.

Authors' Contributions

Conception and design: G. Hoff, P. Berstad
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Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): T. de Lange, G. Hoff
Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): M.D. Knudsen, K.A. Robb, T. de Lange, P. Berstad
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