# Population based cancer screening programmes as a teachable moment for primary prevention interventions. A review of the literature

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**Background and aim:** Unhealthy diet, physical inactivity, and smoking are key risk factors for the major non-communicable diseases such as cancer, cardiovascular diseases, and diabetes. The screening procedure may represent an ideal setting for promoting healthy lifestyles as it represents a time when subjects are probably more inclined to consider a relationship between their own habits and their effects on health. The aim of this study is to review available evidence concerning interventions combining screening and primary prevention interventions, aimed at promoting the adoption of healthy lifestyles. **Methods:** We searched the MEDLINE and Cochrane library electronic databases for intervention studies of primary prevention interventions implemented in the context of established screening programmes, or of pilot screening projects, where the study design included a comparison group. **Results:** Comprehensive interventions are acceptable for asymptomatic subjects targeted for cancer screening, can result in improvements and may be cost–effective. A positive impact of these interventions in favoring the adoption of cancer protective dietary behaviors was observed in all studies. Conflicting results were instead reported with respect to physical activity, while no impact could be observed for interventions aimed to favor smoking cessation. **Conclusions:** The retrieved studies suggest that the screening setting may offer valuable opportunities to provide credible, potentially persuasive life style advice, reaching a wide audience. A multiple risk factor approach may maximize the benefit of behavioral change, as the same health related habits are associated not only with cancers targeted by screening interventions, but also with other cancers, coronary artery disease, and other chronic conditions, while unhealthy behaviors may be mutually reinforcing. In order to cover a maximum number of possibilities, health education programmes should include multiple strategies, integrating and combining models of individual, social, and environmental change.

**Keywords: physical activity, cancer screening, colorectal cancer, breast cancer, cervical cancer, lung cancer, smoking cessation, diet**

## INTRODUCTION

Lifestyle represents an important target for preventive interventions as it is the most important modifiable cause of disease and premature death worldwide (World Health Organization, 2009). Factors that increase the risks of non-communicable disease include use of tobacco, sedentariness, and elevated consumption of energy-dense, nutrient-poor foods, that are high in fat, sugar, and salt.

Evidence for the links between these unhealthy behaviors and diseases and ill-health is strong. Smoking is the leading cause of death and of many diseases both for men and for women (International Agency for Research on Cancer, 2004). In 2007 the World Cancer Research Fund made e review of all scientific studies on the balance between cancer and nutrition, physical activity, or body fatness. Out of all factors that resulted to be associated to an increased cancer risk, overweight resulted to be the strongest. Also, beyond playing an important role on

overweight itself, reduced levels of physical activity at home, at school, at work and for recreation and transport, proved to be an important risk factor associated to neoplastic lesion onset (World Cancer Research Fund/American Institute for Cancer Research, 2007).

Effective interventions to enable people to live longer and healthier lives and to reduce inequalities have been strongly evocated by the scientific community. Whereas among ill people or among those at increased risk it can be easier inducing changes in lifestyle and reducing or eliminating unhealthy behaviors, it becomes much more difficult to introduce these changes among apparently healthy people. Despite this, numbers of studies have pointed out how the effects on the general population of a positive change in lifestyle can be translated into a great gain in terms of health (Fries, 2005).

The circumstance of a cancer preventive examination can work as an ideal setting ("teachable moment," TM) for promoting

healthy lifestyles as they represent a time when subjects are probably more inclined to consider a relationship between their own habits and their effects on health (McBride et al., 2003; Taylor et al., 2007; Lawson and Flocke, 2009).

The label TM has been used to describe naturally occurring life transitions or health events thought to motivate individuals to spontaneously adopt risk-reducing health behaviors. The occurrence of TMs is supported by accepted conceptual models that emphasize the importance of cues in prompting motivation for behavior change. The concept is appealing because timing formal interventions to take advantage of these naturally occurring events might increase the effectiveness of self directed and low-intensity interventions that are also low in cost and amenable to widespread dissemination.

To be invited to perform a test for cancer screening can be seen as a TM because it can increase perceptions of personal risk and outcome expectancies, prompt strong affective or emotional responses, and redefine self-concept or social role. The screening setting can therefore provide a unique opportunity to combine efforts to early detection of cancer among asymptomatic subjects as well as to communicate health education messages to a wide audience at a time when they may be open to learning about reducing cancer risk (van der Aalst et al., 2010). Moreover, such health promoting efforts will likely show a favorable cost–effectiveness ratio, as they can take advantage of the operational features of already established preventive services. Indeed, the screening procedures, in particular in the context of organized programs, provide regular periodic opportunities for personal contacts with health care providers to a huge amount of persons over a long period of time, covering more than 20 years for cervical and breast cancer screening or for colorectal cancer screening programs using FOBT tests.

The aim of our study is to review available evidence concerning interventions combining cancer screening and primary prevention interventions, aimed at promoting the adoption of healthy lifestyles.

## METHODS

### CRITERIA FOR CONSIDERING STUDIES FOR REVIEW

We included studies of primary prevention interventions, focused on lifestyle associated risks, if: (1) they had been implemented in the context of established screening programs or of pilot screening projects; (2) the study design included a comparison group; (3) the intervention aimed at promoting change of single or multiple behavioral risk factors. Interventions targeting patients detected with cancer, as well as surveys assessing unintentional change in lifestyle behavior following screening, not prompted by specific interventions, were excluded. The rationale for the exclusions was to capture high-quality interventions targeting asymptomatic healthy subjects usually invited in population based screening programs.

### SEARCH STRATEGY

We searched the MEDLINE and Cochrane library electronic databases using broad search criteria, including PubMed "related articles" for the papers meeting the criteria for the present review.

The reference lists of the retrieved papers eligible for inclusion were also hand searched in order to find other potentially eligible studies. The search strategy is described in detail in Appendix.

## RESULTS

Out of 670 papers identified by the literature search, 12 (McBride et al., 1999, 2008; Baker and Wardle, 2002; Clark et al., 2004; Emmons et al., 2005a,b; Caswell et al., 2009; Robb et al., 2010; Chellini et al., 2011; Craigie et al., 2011; Stead et al., 2012; van der Aalst et al., 2012) were reporting data on nine randomized lifestyle interventions conducted in the context of screening programs. We included in the analysis (**Table 1**) the main reports of the nine trials (McBride et al., 1999; Baker and Wardle, 2002; Clark et al., 2004; Emmons et al., 2005a; Caswell et al., 2009; Robb et al., 2010; Chellini et al., 2011; Craigie et al., 2011; van der Aalst et al., 2012).

### STUDY SETTING

Four studies were conducted among people participating in CRC screening: a lifestyle intervention was offered to people who had undergone colonoscopy and had adenomas removed (Emmons et al., 2005a; Caswell et al., 2009) and to people undergoing FS screening in the context of experimental or pilot studies (Baker and Wardle, 2002; Robb et al., 2010). Smoking cessation interventions have been implemented among women undergoing cervical cancer screening (McBride et al., 1999) and among male smokers enrolled in an experimental study of lung cancer screening (Clark et al., 2004; van der Aalst et al., 2012). Two additional studies are ongoing among women undergoing cervical cancer screening (Chellini et al., 2011) and among subjects attending FOBT screening for CRC (Craigie et al., 2011).

### POPULATION

All but one study enrolled interested volunteers, making up about 55% of the screening participants targeted for enrollment (range 51–63%). The size of the study arms ranged between 41 and 656 subjects (median: 292).

### FOLLOW-UP AND OUTCOME ASSESSMENT

The duration of follow-up ranged between 6 weeks and 8 months for more comprehensive interventions, addressing multiple behaviors; smoking cessation was assessed at 15 and 24 months. The response rate to the follow-up assessment questionnaires ranged between 69 and 88%.

The intervention impact was assessed in all studies using standardized questionnaires administered at baseline and at follow-up, investigating individuals' knowledge and attitudes as well as health related behaviors. Body weight change was used as an independent marker of behavioral modification in one study (Caswell et al., 2009); biochemical validation of self-reported quitting was used to assess the outcome of one smoking cessation intervention (McBride et al., 1999), while no other study used biological markers associated with diet or exercise modification.

Process evaluation was performed in one study (Emmons et al., 2005a), measuring the costs and resources utilization associated with the intervention and collecting information on patients' experience.

**Table 1 | Characteristics of the reviewed articles.**

| First Author (Year) Country | Sample size | Participants and Setting | Intervention | Outcome | Follow up | Relevant result |
|---|---|---|---|---|---|---|
| McBride et al. (1999), USA | 288 Intervention 292 usual care participants | Women attending cervical screening, mean age. 36.4 years, current smokers, health maintenance organization | Usual care or self-help smoking cessation kit | Smoking behaviour | 6 and 15 months | Self-help intervention vs. usual care: at 6 and 15 months of follow up. Point prevalence abstinence: $p = 0.56$; $p = 0.17$ Quit attempt: $p = 0.29$; $p = 0.62$ Change between follow-up: continuous abstinence: 4.7 vs. 5.6% $p = 0.38$ Smoking cessation: 12.1 vs. 5.6% $p = 0.02$ Relapse: 55.2 vs. 48.8% $p = 0.38$ |
| Baker and Wardle (2002), van der Aalst et al. (2012), UK | 742 Intervention 309 control group participants | 55–64 years, 52% females, National Colorectal cancer screening pilot (sigmoidoscopy) | Brief, tailored, psycho-educational intervention or control group | Fruit and vegetable intake, awareness, attitude | 6 months | Intervention vs. control Daily fruit intake increased with 0.59 servings vs. 0.14 servings ($p < 0.001$) Daily vegetable intake increased with 0.47 servings vs. 0.12 servings ($p < 0.001$) Total daily intake increased with 1.06 servings vs. 0.26 servings ($p < 0.001$) |
| Caswell et al. (2009), UK | 41 Intervention, 33 control group participants | Males and females detected with an adenoma in a population based CRC screening program Mean age Intervention 61.5 Control 63.5 years, Gender (n), intervention vs. control Males: 28 vs. 24 Females: 13 vs. 9 Scottish colorectal screening pilot study | 3-Month intervention with personal contact on personalised lifestyle programme and with three personalised mailings on goal-setting and social support to promote physical activity and dietary fibre, fruit, and vegetable consumption | Fruit and vegetable intake and physical activity | 12 weeks | Intervention vs. control Fibre score: mean (SD) 41 (13) vs. 30 (11) Intervention effect, mean (SE) = + 13 (3) $P = 0.000$ Fruit and vegetable (portions/d), mean (SD) = 7.9 (3.1) vs. 7.3 (4.2) Intervention effect, mean (SE) = +0.6 (0.8) $P = 0.423$ Physical activity (min/day), mean (SD) = 85 (72) vs. 79 (70) Intervention effect, mean (SE) = +24 (16) $P = 0.152$ |

*(Continued)*

**Table 1 | Continued**

| First Author (Year) Country | Sample size | Participants and Setting | Intervention | Outcome | Follow up | Relevant result |
|---|---|---|---|---|---|---|
| Clark et al. (2004), USA | 85 Intervention 86 standard group participants | 51–74 years, 46% females, 60% heavy smokers, current smokers, low-dose fast spiral chest CT screening study | Written self-help materials (control) or internet sources for smoking cessation | Smoking behaviour | 1 year | Intervention vs. control Quit attempts: 68 vs. 48% $p = 0.001$ Point prevalent of smoking: 5 vs. 10% $p = 0.17$ Readiness to quit smoking: 27 vs. 30% $p = 0.70$ Review material: standard group more likely to review all material $p = 0.001$ |
| Emmons et al. (2005a), USA | 591 Intervention (PREVENT), 656 usual care (UC) group participants | 40–75 years, 58.1% males, individuals with an adenomatous colon polyp removed within 4 weeks, PREVENT trial (flexible sigmoidoscopy or colonoscopy in four health care system) | Telephone – delivered intervention by health educator plus tailored self-help materials or information sheet on colorectal cancer prevention (usual care group) | Behavioural risk factors for colorectal cancer: red meat consumption, fruit and vegetable intake, multivitamin intake, alcohol, smoking, and physical inactivity | 8 months | Dropped the risk factor Multivitamin intake: 30 vs. 14% ($p = 0.000$) Read meat: 18 vs. 12% ($p = 0.002$) Fruit and vegetables: 47 vs. 17% ($p = ns$) Alcohol: 4 vs. 2% ($p = ns$) Smoking: 3 vs. 2% ($p = 0.11$) Physical activity: 13 vs. 15% ($p = 0.007$) Patients with (2 risk factors at follow-up among 203 patients with (4 risk factors at baseline: Intervention vs. UC: 43 vs. 19% |
| Robb et al. (2010), UK | 109 Standard leaflet, 103 tailored feedback, 153 control group participants | 59% Female, mean age: 59.2, participants in a CRC screening pilot, pilot programme: flexible sigmoidoscopy screening for colorectal cancer | No behavioural advice, standard leaflet on healthy lifestyle or standard leaflet plus brief, tailored feedback based on responses to a pre-screening questionnaire | Behaviour and knowledge of health recommendations for fruit and vegetable intake, alcohol consumption, and activity levels | 6 months | Meeting health behaviour recommendations controlling for pre-screening level, OR [CI] Fruit and vegetables intake per day Control: 1.00 Standard leaflet: 1.92 [0.94,3.97] Tailored feedback: 2.28 [1.09,4.76] Alcohol units per week Control: 1.00 Standard leaflet: 2.02 [0.40,10.3] Tailored feedback: 1.28 [0.28,6.01] Activity per week Control: 1.00 Standard leaflet: 0.86 [0.41,1.77] |

| Study | Groups | Population | Intervention | Outcome | Follow-up | Results |
|---|---|---|---|---|---|---|
| van der Aalst et al. (2010), The Netherlands | 642 Standard brochure, 642 tailored information group participants | Males smokers enrolled in the Dutch–Belgian lung cancer screening trial (NELSON trial), mean age: 57 years, average cigarettes, smoked/day: 18, average smoking duration: 38 years, Dutch–Belgian lung cancer screening trial (NELSON trial) | Computer tailored smoking cessation intervention (and who completed the tailoring questionnaire received the tailored smoking cessation advice) or standard brochure on smoking cessation | Smoking behaviour | 2 years | Tailored feedback: 1.26 [0.62,2.55] Brochure group vs. tailored information group: Quit attempts, mean (SD): 1.6 (2.4) vs. 1.6 (2.3) $p = 0.62$ Point prevalent smoking abstinence: 15.9 vs. 13.2 $p = 0.18$ Prolonged smoking abstinence: 15.6 vs. 12.5 $p = 0.11$ Continued smoking abstinence: 15.1 vs. 12.1 $p = 0.12$ Analysis with patients who completed tailoring questionnaire and thus received tailored advice (147/642 = 23%) Point prevalent smoking abstinence: 15.9 vs. 14.3 $p = 0.63$ Prolonged smoking abstinence: 15.6 vs. 14.3 $p = 0.70$ Continued smoking abstinence: 15.1 vs. 14.3 $p = 0.12$ |
| Craigie et al. (2011), UK | 158 Intervention 158 usual care participants | Screening patients, aged 50–74 years, NHS CRC screening programme (Study protocol) | General leaflet on healthy lifestyle plus BEWEL personalized intervention program, personal body weight scales supervised monthly body weight recordings and face-to face visits and monthly telephone/email contacts or a general leaflet on healthy lifestyle (usual care) | Behaviour change, diet, physical activity | 3 and 12 months | Study protocol |
| Chellini et al. (2011), Italy | 363 Smoking cessation counselling, 366 smoking cessation counselling + PA (physical activity), 371 control group | Women undergoing cervical cancer screening in three study centres; current smokers, mean age = 43.5 years (range 25–64 years), National Health System Cervical screening Program (NHS-CCSP) | Tailored smoking cessation counselling, tailored counselling for smoking cessation + physical activity, self-help booklet on smoking cessation and increasing PA for all participants | Smoking behaviour and changes in PA | 6 and 12 months | Study protocol |

## CHARACTERISTICS OF THE INTERVENTIONS

Four studies were focused on providing advice on a specific risk factor: one examined the efficacy of an educational intervention for increasing fruit and vegetable intake (Baker and Wardle, 2002) and the other three (McBride et al., 1999; Clark et al., 2004; van der Aalst et al., 2012), assessed the impact of smoking cessation counseling. The remaining five studies addressed multiple health related behaviors, including dietary habits, physical activity, alcohol intake, and smoking. The main focus of all interventions aimed at promoting change of dietary behavior was on increasing daily fruit and vegetable intake; increase of fiber and multivitamin intake and reduction of red meat consumption were also recommended in some interventions.

In all studies, participants randomized to the intervention group were offered a personalized program for achieving the desired change. The intensity of the interventions can be classified in two levels: minimal contact (Baker and Wardle, 2002; Clark et al., 2004; Robb et al., 2010; van der Aalst et al., 2012) and intensive counseling interventions (McBride et al., 1999; Emmons et al., 2005a; Caswell et al., 2009). Subjects who were offered low-intensity minimal contact interventions were asked to fill a baseline assessment questionnaire, including self-reported items on health related behaviors and on knowledge of lifestyle recommendations, and assessing the individual's level of motivation and readiness for change. They were then mailed tailored written self-help materials providing feed-back on their reported habits and a personalized behavioral modification program with suggestions on strategies that could be helpful to achieve the recommended goals. No personal encounter was offered.

Intensive counseling interventions involved as well a baseline assessment, performed at the time of a personal (Caswell et al., 2009) or telephone (Emmons et al., 2005a) counseling session, aimed at gathering information on individual's lifestyle, motivation, and stage of change and to stipulate a personalized program. Initial advice was then reinforced by multiple personalized mailings of tailored self-help material (Caswell et al., 2009), or by multiple telephone counseling sessions supported by tailored self-help materials sent by mail (McBride et al., 1999; Emmons et al., 2005a). The phone follow-up sessions were aimed at offering practical guidance to accomplish the recommended goals, taking into account individual's ability and self-efficacy for behavioral change. Progress reports in tandem with the follow-up calls were used to reinforce individual's goals and address areas that needed further consideration.

## INTERVENTIONS EFFECTS

A minimal contact program based on a single mailing of tailored advice was effective in inducing an increase in the proportion of people meeting the recommendations for fruit and vegetables intake, both (Baker and Wardle, 2002) at 6 weeks (+17%) and (Robb et al., 2010) at 6 months (+7%), compared to no intervention or to the simple delivery of standard information brochures, while no effect could be observed in the smoking cessation rates or on physical activity. Intensive counseling interventions (Emmons et al., 2005a; Caswell et al., 2009), including phone follow-up session and/or mailings of tailored self-help materials, were associated with significant increase in the proportion of participants

reporting change in multiple unhealthy behaviors at 3 (+34%) and 8 months (+12%). When analyzing individual risk factors, anti-smoking interventions were not associated with an increase in quitting rates, while the impact of dietary habits was comparable to the effect achieved with minimal interventions. Also, although participants in one study tended to show a lower rate of regression in their level of physical activity over 8 months, compared to the controls, the intervention effect on the level of activity was low. As the follow-up time for more comprehensive interventions ranged between 6 weeks and 8 months, it is not possible to assess their impact on long-term lifestyle change.

The estimated cost–effectiveness of an intensive counseling intervention, measured as the net-cost (additional cost of the intervention over the usual care costs) to achieve the recommended goal for a single risk behavior was 379 $ per risk factor dropped (Emmons et al., 2005a).

The drop-out rate in the intensive counseling interventions ranged between 19% over a 3-month (Caswell et al., 2009) and 40% over a 5-month intervention period (Emmons et al., 2005a); about 90% of the intervention participants rated the material and the counseling calls as helpful or very helpful (Emmons et al., 2005a).

## ONGOING STUDIES

We found two published protocols of ongoing intervention studies conducted in the context of population based screening programs. The first study targeted women undergoing Pap-smear for cervical cancer screening (Chellini et al., 2011): participants have been randomized to receive smoking cessation counseling or smoking cessation counseling supplemented by physical activity advice. One year self-reported quitting rates in the intervention groups will be compared with the rates recorded in the control group. The second study is targeting people detected with an adenoma following a positive FOBT screening test (Craigie et al., 2011): subjects detected with an adenoma who volunteer for enrollment will be randomized to receive a personalized lifestyle intervention program (addressing diet and physical activity), or to receive a general healthy lifestyle information leaflet (usual care). The impact of the intervention on body weight, waist circumference, and cardiovascular risk profile will be assessed at 3-year follow-up. The theoretical framework guiding the design and development of the interventions tested in both studies was the stages of change model (Prochaska et al., 1994).

## DISCUSSION

The insight gained from the reported investigations can provide relevant indications concerning methodological aspects that should be addressed in future work, related to the choice of the study setting, the target population, the definition and measure of the outcomes of interest and the reference framework for the design and implementation of the interventions.

## SETTING

Several interventions have been offered, or are planned, for people undergoing CRC screening. The focus on this specific setting may be related to the findings of a recent study (Larsen et al., 2007) showing that at 3-year follow-up, attendees in a pilot sigmoidoscopy trial of CRC screening who had a negative exam reduced

their fruit and vegetable intake, gained more weight and did not improve their smoking habits or their physical activity as successfully as subjects in the control group. Although these findings were not confirmed in the short term follow-up of a similar pilot program (Miles et al., 2003), the results of a recent qualitative study (Stead et al., 2012) among subjects having been diagnosed with an adenoma, following a positive FOBT result, would confirm that endoscopic screening might pose specific challenges for prevention. In fact patients detected with an adenoma tended to feel no need to modify their lifestyle, as if the test result, indicating a clean colon, together with the reassurance offered by professionals during the process, could be interpreted as a validation of the current lifestyle, which would not, therefore, require modification. These findings support the efforts aimed at assessing the effectiveness of strategies aimed at promoting behavioral change by making explicit the connection between lifestyle and CRC or adenoma incidence and recurrence.

We could not find reports of health education interventions targeting participants in breast cancer screening, even if several factors would suggest a potential for health promoting interventions to modify unhealthy behaviors and to achieve favorable health impact. Current evidence links several lifestyle factors, including dietary habits and physical activity, to the risk of breast cancer (World Cancer Research Fund/American Institute for Cancer Research, 2007) and the findings of lifestyle modification interventions offered to women with a previous diagnosis of breast cancer, showed a reduction of cancer recurrence rates (Andersen et al., 2008). Also, according to the findings of a recent survey among breast cancer screening attendees in UK (Fisher et al., 2007) women would welcome having diet and exercise advice.

The preliminary results of the ongoing trial (Chellini et al., 2011) of smoking cessation and physical activity counseling, delivered to women undergoing cervical cancer screening, indicated that recruited smokers were less educated women who usually smoke more and have more difficulties to quit, which would confirm the high potential for health promotion also in this setting.

## POPULATION

All but one study enrolled screening participants who were interested in receiving health education advice. Therefore, although no significant difference with respect to socio-demographic characteristics and health behavior was observed between those who did or did not volunteer in the only one study addressing this issue (Baker and Wardle, 2002), self-selection of subjects with a different risk profile, or more motivated toward cancer prevention compared to the general population, cannot be ruled out. Moreover, it should be considered that, according to several reports (Sutton et al., 2000; Blom et al., 2008; Phillips and Coldman, 2008; Shapiro et al., 2011), screening participants already represent a self-selected sub-group of the target population, often showing a healthier lifestyle compared to non-participants. Indeed, in the only study included in this review enrolling all screenees over 95% of subjects already met the recommendations for alcohol intake at baseline, which would suggest self-selection of health-oriented subjects (Robb et al., 2010).

As long as the proposed interventions require personal involvement and commitment to change recruitment of interested volunteers seems an appropriate strategy to assess their effectiveness. A systematic analysis of the individual's characteristics associated with the decision to engage in a primary prevention intervention can represent however a relevant aim for future research, to understand how contextual factors may strengthen or undermine the motivational potential of health events and their likelihood to become TM. This would also enable to understand better what circumstances prompt motivation to change as a coping response to health events and it would allow to identify possible socio-economical barriers undermining equity of access to effective interventions.

All lifestyle interventions targeting risk behaviors other than smoking were offered to people over 50 years of age, while smoking cessation was promoted among younger populations attending cervical cancer screening. Although the cancer protective effect of quitting might tend to decrease with age, the potential for a favorable impact of smoking cessation on several health outcomes would not justify the choice to limit the inclusion of such component to those health education interventions targeting younger people. On the other end, further research is needed to assess the potential benefit of lifestyle interventions addressing dietary habits or exercise level among younger age groups, at a time when the prevalence of chronic diseases is still low.

## EVALUATION

The choice of the relevant outcomes and of the instruments used to measure the intervention effect deserve careful consideration. With respect to smoking, it was already shown that self-report may be inaccurate when assessing the impact of a cessation intervention and validated measures of abstinence have been recommended when assessing preventive interventions.

Food-frequency and physical activity questionnaires have been validated in different socio-cultural contexts and they have been used also in observational studies aimed to assess the role of these factors as predictors of chronic disease risk. Therefore the adoption of these instruments seems appropriate also when measuring the effect of a dietary of physical activity intervention. However, it might be advisable to combine standardized self-reported assessments of behavior change with some measure of the expected effects associated with these changes, such as body weight or BMI, waist circumference ad eventually also markers of modification of metabolic and hormone profile (i.e., insulin and sexual hormones), building on the experience of previous studies of lifestyle change in cancer patients. Also, as long as the targeted behaviors are associated with a number of cancers but also to coronary artery disease and other chronic conditions, it might be worth to assess the relevance of other outcomes reflecting the health impact of behavioral changes such as, for example, hospitalization rates (eventually stratified by cause). The assessment of these outcomes might be relevant as well for the purposes of cost–effectiveness analyses.

Also, gathering information on the intervention process, including acceptability and patients satisfaction with the proposed approaches, as well as data on resources utilization and costs, explored just in one study, might offer helpful hints to tailor the methods of access to the proposed interventions and to get more insight about the sustainability over time of the proposed approaches.

Finally, as long as behavioral change is a process rather than a state, the risk of relapse after a short term follow-up should be taken into account. The impact of interventions addressing dietary and physical activity habits was assessed only in the short term (range: 6 weeks to 8 months) and it is unknown whether the observed change could be maintained over time. Future work should focus on the assessment of long-term follow-up, with objective measures of outcome and impact, to derive information on the barriers and on the most effective strategies to support maintenance of the achieved change over time.

## INTERVENTIONS CHARACTERISTICS

All but one interventions have been designed based on the stages of change model (Prochaska et al., 1994) and also the one grounded in the social cognitive theory (Emmons et al., 2005a), was in fact assuming that behavioral change can be viewed as a step-wise process, influenced by intra- and inter-personal factors. The adoption of a common validated theoretical framework, already tested in several primary prevention projects, favors the comparability of the results and provides a basis for comparisons to determine successful intervention components. However, the effectiveness of this conceptual framework in supporting the implementation of interventions which may achieve a long-lasting impact was not tested, while the reported results when targeting exercise or smoking behaviors seem to highlight possible limitations.

Tailored interventions, even when using only written self-help materials, were shown to be effective in prompting the adoption of healthier dietary patterns in the short term, but they did not increase smoking quitting rates and showed a limited impact on physical activity, even if reinforced by multiple stage-matched personal counseling sessions delivered during the implementation phase of the stipulated behavioral change.

In the case of the smoking cessation interventions tested in the retrieved studies, the absence of any intervention effect might be explained by the lack of the offer of pharmacological support or of the access to smoking cessation clinics. These external supports have already been shown to be effective, in particular for heavy, more dependent smokers (Stead et al., 2008). These findings would suggest that interventions focused on the cognitive components of behaviors associated with the phases of the individual's progress in the process of change, may not be sufficient to induce and sustain the adoption of new habits.

Indeed, other more comprehensive health education frameworks, such as the PRECEDE–PROCEED model (Green and Kreuter, 2005), explain behavioral change as the result of the interplay of factors providing the rationale or the motivation for the behavior (*predisposing* factors, such as knowledge, beliefs, values, attitudes, confidence, capacity), of factors *enabling* actual realization of the decision (availability and/or accessibility of health resources, community/government laws, priority, and commitment to health, health related skills), and of factors sustaining individuals in maintaining the adopted behavior over time (*reinforcing* factors such as family, peers, teachers, employers, health providers, community leaders, decision makers). Even if removing environmental barriers to change may not be useful if the individual has not yet moved to an appropriate degree of readiness to change, a broader view taking into account individual's cognition and readiness for change together with context related factors might enhance the impact of these interventions. This approach might be useful also for supporting maintenance of dietary or physical activity modifications: the offer of practical support, in terms of cooking teaching sessions, access to healthy foods or to sport or recreational facilities at discounted price might favor the adoption and the maintenance of the desired goals for change. This latter issue is also related to the general aim to ensure equity of access to these interventions.

## CONCLUSION

Unhealthy diet, physical inactivity and smoking are key risk factors for the major non-communicable diseases such as cancer, cardiovascular diseases, and diabetes.

Consistent with the TM heuristic, the retrieved studies suggest that the screening setting may offer valuable opportunities to provide credible, potentially persuasive life style advice, reaching a wide audience. A multiple risk factor approach may maximize the benefit of behavioral change, as the same health related habits are associated not only with cancers targeted by screening interventions, but also with other cancers, coronary artery disease, and other chronic conditions, while unhealthy behaviors may be mutually reinforcing. Targeting simultaneously multiple factors may maximize the impact of the intervention (Emmons et al., 2005b; McBride et al., 2008), as change in one habit may act as a gateway for change in another risk behavior (i.e., increasing physical activity may reduce the risk of weight gain, which represents a barrier for smoking cessation), or it may enhance the effect of another intervention (i.e., the combined effect of diet and physical activity on weight reduction), and it may as well reduce the risk of other conditions (i.e., cardiovascular diseases) conditions.

Available evidence from intervention studies provides support to the hypothesis that comprehensive interventions are acceptable for asymptomatic subjects targeted for cancer screening, can result in improvements, and, according to preliminary analyzes, may be cost–effective. A positive impact of these interventions in favoring the adoption of cancer protective dietary behaviors was observed in all studies. Conflicting results were instead reported with respect to physical activity, while no impact could be observed for interventions aimed to favor smoking cessation.

The tailored approach, adopted in almost all studies, seems more effective than interventions based on the delivery of standard information, or generic advice about lifestyle change, as it enables personalized feed-back regarding individual's patterns of health, framed in a manner appropriate to individual's stage of change. However, environmental barriers may limit individuals' possibilities to implement their decision to change, while it is now widely recognized that the context shapes the behavioral choices of individuals. Therefore a cognitive approach to behavior may no longer be sufficient to design effective strategies to influence health behaviors. Indeed it has been recommended that, in order to cover a maximum number of possibilities, health education programs should include multiple strategies, integrating the goals of changing the context and changing cognition and combining models of individual, social, and environmental change.

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## APPENDIX

### SEARCH STRATEGIES

["Colorectal Neoplasms" (MeSH Terms) OR colorectal neoplasm] AND ["Mass Screening" (Mesh) OR screening] AND [diet OR physical activity OR "Diet∗" (MeSH Terms) OR "Exercise" (MeSH Terms) OR "Life Style∗" (MeSH Terms) OR lifestyle].

### Limits Activated

English, French, German, Italian, Spanish, Publication Date from 2000/01/01 to 2012/01/30.

The search retrieved a total of 100 papers. The PubMed search for "related articles" for relevant retrieved papers lead to identification of other 117 papers.

["Breast Neoplasms" (Mesh) OR "Mammography" (Mesh) OR mammography] AND ["Mass Screening" (Mesh) OR screening] AND [diet OR physical activity OR "Diet∗" (MeSH Terms) OR "Exercise" (MeSH Terms) OR "Life Style∗" (MeSH Terms) OR lifestyle].

### Limits Activated

English, French, German, Italian, Spanish, Publication Date from 2000/01/01 to 2012/01/25.

The search retrieved a total of 144 papers.

["Colorectal Neoplasms" (MeSH Terms) OR colorectal neoplasm OR "Breast Neoplasms" (Mesh) OR "Mammography" (Mesh) OR mammography OR "Cervical Intraepithelial Neoplasia" (Mesh) OR "Uterine Cervical Neoplasms" (Mesh) OR "Papillomavirus Infections" (Mesh) OR cervical cancer] AND ["Mass Screening" (Mesh) OR screening] AND ["Smoking Cessation" (Mesh) OR "Smoking" (Mesh) OR smoking cessation] AND ["Health Promotion∗" (Mesh) OR "Health Education" (Mesh) OR "Health Behavior∗" (Mesh) OR "Intervention Studies" (Mesh) OR teachable moment OR "Attitude to Health" (Mesh)].

### Limits Activated

English, French, German, Italian, Spanish.

The search retrieved a total of 121 papers.

The PubMed search for "related articles" for relevant retrieved papers lead to identification of other 168 papers.