



**Do health behaviours change after colonoscopy? A prospective cohort study on diet, alcohol, physical activity and smoking among patients and their partners.**

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Manuscripts

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7 **Do health behaviours change after colonoscopy? A prospective cohort study on diet,**  
8 **alcohol, physical activity and smoking among patients and their partners.**  
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30 **Word count:** 2,679

**ABSTRACT****Objectives**

We hypothesised that colonoscopy triggers changes in health behaviours. Our objective was to describe diet, alcohol, physical activity and tobacco use before and after colonoscopy for patients and their partners.

**Design**

Prospective cohort study of patients and their partners before and 10 months after colonoscopy.

**Setting**

5 Scottish hospitals.

**Participants**

Of 5,798 colonoscopy registrations, 2,577 (44%) patients met eligibility criteria of whom 565 (22%) were recruited; 460 partners were also recruited.

**Measures**

International Physical Activity Questionnaire, Scottish Collaborative Group Food Frequency Questionnaire (includes alcohol), smoking status, age, sex, education, household income, employment status, Scottish Index of Multiple Deprivation (SIMD), Body Mass Index, medical conditions, result of the colonoscopy (abnormal result notification (ARN) or normal result notification (NRN)), Multidimensional Health Locus of Control Scale (MHLC), behaviour-specific self-efficacy scales.

## Results

57% of patients were male, mean age 60.8 years (SE 0.5) and 43% were from more affluent areas. Response rate to the second questionnaire at 10 months was 68.9%. Overall, 27% of patients consumed less than 5 measures of fruit & vegetables per day, 20% exceeded alcohol limits, 50% had low levels of physical activity and 21% were obese. At 10 month follow-up, a 5% reduction in excessive alcohol consumption and an 8% increase in low levels of physical activity were observed among patients; no significant behavioural changes occurred in their partners. Baseline high alcohol consumption and low physical activity were the strongest predictors of these behaviours at follow-up. Additionally, low alcohol self-efficacy and increasing age were associated with poorer health-related behaviours at follow-up for alcohol and physical activity, respectively.

## Conclusions

Colonoscopy can be regarded as a teachable moment for patients, being associated with changes in some health behaviours. Further work is needed to explore how services can optimize increases in beneficial health behaviours and mitigate increases in harmful ones.

## Article summary

### Article focus

- Colonoscopy is an increasingly common investigation that might trigger spontaneous behavioural changes in patients.
- Little is known about health behavior change following colonoscopy, particularly in the UK.
- We carried out a prospective cohort study of patients who underwent colonoscopy and their partners.

### Key messages

- There is a high prevalence of unhealthy behaviours in colonoscopy patients.
- We observed significant reductions in excessive alcohol consumption but also decreases in physical activity following colonoscopy.
- There may be opportunities to encourage spontaneous improvements in health behaviours among colonoscopy patients and to mitigate harmful behaviours.

### Strengths and limitations of this study

- This is the first observational study on health behaviours in colonoscopy patients in the UK.

- We obtained a large sample size and high follow-up rate and were able to use patients' partners as controls.
- Selection biases may have led to our sample comprising healthier patients than in the general colonoscopy population.

For peer review only

## INTRODUCTION

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Illnesses and interactions with health services may motivate patients to change their behaviours. Such “teachable moments” have been described for changes in smoking behaviour following life transitions, such as pregnancy, and health events, such as screening for lung cancer.<sup>1,2,3,4,5,6,7,8,9,10</sup> A recent review of the literature concludes that while the term “teachable moment” is used imprecisely – to describe either an opportunity for behavioural change or an event associated with actual change - there is evidence that beneficial behavioural changes can be actively created through appropriate clinician-patient interactions.<sup>11</sup> To our knowledge, evidence from the UK that patients who undergo screening for cancer are likely to make improvements in health behaviour is limited to a single pilot study of a health promotion intervention delivered during colorectal cancer screening.<sup>12</sup> The evidence from observational research that there are spontaneous health behaviour changes after a cancer diagnosis is limited to retrospective analyses of population surveys that depend on self-reported cancer diagnosis.<sup>13</sup> Relatives of cancer patients may also change their behaviour in response to a familial diagnosis, but the evidence is limited to one study on breast cancer.<sup>14</sup>

Colonoscopy is mainly performed for the diagnosis of colon and rectal cancer and current UK rates of 80 procedures per 10,000 population are likely to increase in the future as screening by flexible sigmoidoscopy is introduced.<sup>15</sup> The number of colonoscopies performed through the Scottish bowel screening programme almost doubled from 5,358 in 2009 to 9,296 in 2011; in England, 368,162 colonoscopies were carried out in 2009-10.<sup>16,17</sup> We hypothesised that colonoscopy represents both concepts of a teachable moment for health behaviour change: it may be a time of concern about a cancer diagnosis and thus be associated with



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3 spontaneous change,<sup>1,18</sup> and it may also present an opportunity for clinicians to promote  
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5 improvements in behaviours. An abnormal colonoscopy result may be more likely to trigger  
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7 changes in behaviour, so we compared behaviours between participants with normal and  
8  
9 abnormal test results. Our aim was to describe health-related behaviours before and after a  
10  
11 colonoscopy among patients and their partners. Our objective was to carry out a  
12  
13 prospective observational study on colonoscopy patients and their partners using self-  
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15 reported questionnaire survey data immediately before and ten months after colonoscopy.  
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17 As self-efficacy and locus of control are central to several health behaviour theories,  
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19 including the Health Belief Model,<sup>19</sup> Social Cognitive Theory<sup>20</sup> and Protection Motivation  
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21 Theory,<sup>21</sup> we assessed their roles using validated questionnaires and also recorded physical  
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23 activity, tobacco smoking and alcohol consumption.  
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## 31 **METHODS**

### 32 **Study design**

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37 Prospective cohort study of health behaviours of patients referred for colonoscopy and their  
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39 partners.  
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### 43 **Setting**

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46 Colonoscopy clinics in five hospitals within three Health Board areas in Scotland, UK.  
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48 Recruitment occurred between September 2010 and August 2011.  
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### 51 **Participants**

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55 Patients were invited by an advert for the study enclosed along with their colonoscopy  
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57 appointment letter from the hospital. On attendance for colonoscopy, clinic staff obtained  
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3 verbal consent for patients (and, if present, their partners) to allow the Research Assistant  
4 (RA) to approach them. If a patient did not wish to be approached by the RA, consent was  
5 sought to retain non-identifiable data (age, sex and sector level of the postcode) to assess  
6 selection bias. The RA asked consenting participants to complete the baseline (T1)  
7 questionnaire and written consent form at home and return both in a pre-paid addressed  
8 envelope. Patients whose partners were not present were asked to provide the name and  
9 contact details of their partner who was subsequently contacted by the RA by telephone  
10 about the study.  
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### 22 **Eligibility criteria**

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24 Patient inclusion criteria were: i) referred for colonoscopy, ii) no past history of cancer, iii)  
25  $\geq 18$  years old, iv) has a partner. Partner inclusion criteria: i)  $\geq 18$  years old, ii) no history of  
26 cancer.  
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### 33 **Variables, measures and data sources**

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35 Information was self-reported by participants or obtained from medical records.  
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#### 39 Heath-related behaviour variables

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41 The International Physical Activity Questionnaire<sup>22,23</sup> was used to categorise participants into  
42 low, moderate or high levels of PA using Metabolic Equivalent of Task (MET) scores. The  
43 Scottish Collaborative Group Food Frequency Questionnaire (SCG FFQ)<sup>24,25</sup> was used to  
44 measure intakes of foods and alcohol. Current smokers were defined as those who had  
45 smoked at least 100 cigarettes in their entire life and currently smoked.  
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54 An aggregate risk behaviour score was calculated based on generally accepted requirements  
55 for risk factor reduction for most of the main chronic diseases and specifically for prevention  
56 of colorectal cancer because colonoscopy is a main investigation for colorectal cancer  
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3 symptoms.<sup>26,27</sup> Specifically, we defined high risk behaviour using Scottish government  
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5 recommendations<sup>28,29,30</sup> as follows: <5 measures/day of fruit and vegetables; <3 portions/day  
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7 of bread; >4 (men) and >3 (women) units/day of alcohol; current smoker; and low physical  
8  
9 activity (equivalent to less than thirty minutes of moderate intensity activity on at least 4  
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11 days of the week). For the purpose of this study, a 'measure' as defined in the SCG FFQ was  
12  
13 assumed to be equal to a 'portion' of fruit or vegetables.  
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#### 16 17 Demographic variables

18  
19 Participants self-reported their age, sex, level of education, household income, employment  
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21 status, and postcode (to calculate Scottish Index Multiple Deprivation (SIMD<sup>31</sup>)).  
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#### 24 25 Clinical variables

26  
27 Body Mass Index (BMI) was calculated by dividing weight (kg) by height squared (m<sup>2</sup>) using  
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29 self-reported values. Participants were categorised as obese if BMI $\geq$ 30.0 kg/m<sup>2</sup>. Participants  
30  
31 self-reported their medical conditions currently being treated by a doctor. Result of the  
32  
33 colonoscopy was obtained from patient medical records. Patients were categorised as  
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35 receiving a normal result notification (NRN) or abnormal result notification (ARN) such as,  
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37 colorectal cancer, polyps or diverticulitis.  
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#### 43 44 Psychological variables

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46 Participants' perceived control over their health-related behaviours was measured using the  
47  
48 Multidimensional Health Locus of Control Scale<sup>32,33</sup>. The instrument measures three  
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50 dimensions of control: internal, powerful others and chance. Participants' self-efficacy was  
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52 measured using four separate self-efficacy scales (smoking, diet, alcohol, PA) recommended  
53  
54 by Schwarzer and colleagues.<sup>34</sup> There is no cut-off score to define persons as being high or  
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56 low self-efficacious so we split the sample at the median, as recommended by Schwarzer.  
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## Data collection

The baseline (T1) questionnaire was administered to patients who attended a colonoscopy clinic between September 2010 and August 2011. A pre-paid envelope was provided for participants to return the questionnaire after completing it at home. The follow-up questionnaire (T2) was posted 10 months after the clinic date for colonoscopy, between July 2011 and June 2012.

## Bias

We attempted to minimise information biases by using, where possible, validated questionnaires and to minimise selection biases by inviting all colonoscopy patients to participate.

## Sample size and statistical analysis

Statistical analysis was carried out using Stata/SE 11.2 software. Means  $\pm$  standard errors or medians [interquartile range (IQR)] were presented as appropriate following visual assessment of histograms of continuous variables. Differences in characteristics and behaviours between groups were assessed using Pearson's chi-squared test for categorical measures and either T-tests or Mann-Whitney tests for continuous variables as appropriate. Differences in continuous variables between T1 and T2 were assessed using a paired T-test or the Wilcoxon signed-rank test. Differences in categorical variables between T1 and T2 were assessed in SPSS version 20 using the McNemar-Bowker test for variables with 3 or more categories, and the McNemar test for binary variables. To predict health-related behaviour at T2 logistic regression models were undertaken.

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3 This paper reports a comparison of changes in health behaviours of patients with NRN and  
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5 ARN following colonoscopy. However, the study had initially aimed to detect an increase in  
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7 physical activity of 25 or greater MET hours in patients diagnosed with cancer at  
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9 colonoscopy compared to non-cancer patients, and samples of 46 cancer and 46 non-cancer  
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11 patients would have been required. The effect size was derived from Satia,<sup>35</sup> and sample  
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13 size calculations assumed conventional values of  $\alpha=0.05$  and  $\beta=0.20$  (giving a power, or  $1-\beta$ ,  
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15 of 80%). Thus, our study numbers exceeded those required by the initial sample size  
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17 calculation.  
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## 22 RESULTS

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27 Of 5,798 colonoscopy registrations, 2,577 patients (44%) met eligibility criteria for the study  
28  
29 of whom 565 (22%) eligible patients and 460 partners were recruited (**Error! Reference**  
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31 **source not found.**). Recruited patients compared to non-recruited patients were  
32  
33 significantly older ( $60.3 \pm 0.5$  versus  $57.2 \pm 0.4$ ), more affluent (Carstairs decile 1 and 2, 43%  
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35 versus 29%) and a higher proportion male (57% males versus 50% male). Overall, 68.9%  
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37 (n=706) of participants returned a second, follow-up questionnaire at T2.  
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42 **{Please insert Figure 1 here}**  
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47 At baseline (T1), a higher proportion of patients with abnormal result notification (ARN)  
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49 were male, older, retired, and with a household income under £20,000 compared to  
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51 patients with normal result notification (NRN) - **Error! Reference source not found.** Overall  
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53 27% consumed less than five measures a day of fruit/vegetable, 20% exceeded  
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55 recommended alcohol limits, 50% had low levels of physical activity and 21% were obese.  
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57 Higher proportions of ARN patients were not meeting these recommendations but the  
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3 difference was only significant for physical activity. Only 11% of patients reported current  
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5 smoking. When combined, overall 52% of participants had 2 or more risk behaviours, which  
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7 comprised 55% of ARN and 42% of ARN.  
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11 **{Please insert Table 1 here}**  
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16 There were no significant differences between patients with abnormal and normal results  
17  
18 with respect to self-efficacy for smoking cessation, physical activity, diet and alcohol (Table  
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20 2). Partners of patients with normal results were more likely to have low self-efficacy for  
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22 smoking cessation.  
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28 **{Please insert Table 2 here}**  
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32 Overall, there was a 5% reduction in respondents who exceeded alcohol consumption  
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34 guidance and an 8% increase in the proportion with low physical activity - **Error! Reference**  
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36 **source not found..** The proportionate increase in low physical activity was similar in  
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38 patients with abnormal and normal colonoscopy results but statistically significant only  
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40 among those with abnormal findings (which might be explained by the larger sample size in  
41  
42 the abnormal category). When risk behaviours were aggregated, there was no overall  
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44 change in behaviours in any patient group. We found no significant change in health  
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46 behaviours of partners, irrespective of the colonoscopy result of the patient (data not  
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48 shown).  
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54 **{Please insert Table 3}**  
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5 We used multiple logistic regression analyses to explore predictors of the two behaviours  
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7 that changed significantly over time: low physical activity and high alcohol intake - **Error!**

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9 **Reference source not found..** Low physical activity at baseline was the strongest predictor of  
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11 low physical activity at T2 among patients and increasing age was also associated with lower  
12  
13 physical activity. Sex, socio-economic circumstances, co-morbidities, colonoscopy findings  
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15 and self-efficacy did not predict changes in physical activity over time.  
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20 **{Please insert Table 4}**

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22 Excessive alcohol consumption at T2 was most strongly determined by excessive  
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24 consumption at baseline - **Error! Reference source not found..** Lower self-efficacy at T1 was  
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26 associated with higher alcohol consumption at T2. Age, sex, socio-economic circumstances,  
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28 co-morbidities and colonoscopy findings were not associated with higher alcohol intake at  
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30 follow-up.  
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35 **{Please insert Table 5}**

## 36 37 38 39 **DISCUSSION**

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41 Colonoscopy is associated with spontaneous changes (that is, without a behavioural  
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43 intervention) in some health-related behaviours. We found that there was a 5% reduction in  
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45 excessive alcohol consumption but an 8% increase in low levels of physical activity 10  
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47 months after colonoscopy. There were no significant changes in health behaviours among  
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49 patients' partners, suggesting that behavioural changes in colonoscopy patients were not  
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51 necessarily part of wider temporal trends. No behavioural advice was given to patients as  
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53 part of their investigations, and thus colonoscopy might be regarded as a teachable moment  
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55 in which spontaneous changes are triggered. However, colonoscopy also represents an  
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3 interaction with health services that might be optimized to encourage improvements in  
4 health-related behaviours. This conclusion is similar to a recent systematic review of eleven  
5 articles about the impact of cancer screening (nine of which investigated the impact of lung  
6 screening on smoking cessation) which concluded that cancer screening 'might' be a  
7 teachable moment for health behaviour change<sup>36</sup>. We found that baseline health  
8 behaviours for low physical activity and excessive alcohol consumption were the strongest  
9 predictors of the same behaviours 10 months after colonoscopy but, additionally, increasing  
10 age predicted lower physical activity and lower self-efficacy around alcohol predicted  
11 excessive alcohol consumption at follow-up. Among our patient sample, 11% smoked,  
12 which is much lower than the Scottish general adult population prevalence of 23%.<sup>37</sup>  
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27 This study found that a low level of PA at the time of colonoscopy and older age were  
28 predictive of a low level of PA 10 months post-colonoscopy. Further, high alcohol intake at  
29 the time of colonoscopy and low alcohol self-efficacy were predictive of high alcohol intake  
30 post-colonoscopy. Of note, fatalism (MHLC Chance score) was not predictive of any  
31 differential health behavior change. ARN was not predictive of health behaviour change  
32 following this health event, which is in contrast to studies of smokers under-going screening  
33 for lung disease.<sup>38,39</sup> A cross-sectional study of over 10,000 smokers at 2-3 years post-  
34 screening for COPD found that those with a first-time positive result were significantly more  
35 likely to stop smoking than those with a negative result<sup>38</sup>. A cross-sectional study of 134  
36 active smokers who underwent spiral CT screening found that 62% of those with a positive  
37 result either stopped or decreased smoking, whereas only 46% with a negative result did  
38 so.<sup>39</sup> Thus, the effect of test results following screening for disease on health-related  
39 behaviour appears to vary according to type of screen (e.g., colonoscopy versus spiral CT),  
40 reason for screening (e.g., colon disease versus lung disease) and health-related behaviour  
41 (e.g., alcohol versus smoking).  
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5 Our study has strengths and limitations. This is the first prospective observational study to  
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7 report health-related behaviours of patients and their partners before and 10 months after  
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9 colonoscopy. We used validated questionnaire survey tools, obtained a relatively large  
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11 sample for a prospective cohort study and achieved high follow-up rates of 69%. There are  
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13 however, several study limitations. First, the sample may not be representative of all  
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15 patients population undergoing colonoscopy. The response rate of eligible patients was 22%,  
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17 and there was some selection bias towards a more affluent, older and male population.  
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19 Socio-economic affluence may explain why our sample had lower smoking prevalence than  
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21 the general population. Patients who participate in the newly introduced national colorectal  
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23 cancer screening programme also may be more likely to be motivated to change in their  
24  
25 behaviour. Although valid and reliable survey instruments were used, self-reported data are  
26  
27 susceptible to expectation biases and other misclassification effects.<sup>40</sup> However, our  
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29 principal interest was in behavioural change rather than absolute prevalences of behaviours,  
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31 and thus over- or under-reporting of certain behaviours would not necessarily invalidate our  
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33 findings on whether they changed after colonoscopy. The observed decreases in excessive  
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35 alcohol consumption and in physical activity following colonoscopy may not be caused by  
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37 the procedure but by other confounding factors that we have not identified. We are not  
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39 aware of any health promotion activity associated with colonoscopy as it was delivered  
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41 within the participating hospitals and our questionnaires were designed not to imply any  
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43 favourable behaviours. The fact that there were no observed changes in partners and no  
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45 differences between ARN and NRN patients suggests that the observed behavioural changes  
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51 in patients was related to the colonoscopy.

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56 Health care settings are recognised as important loci for promoting health behaviour  
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58 change<sup>41,42,43</sup> and health events have been conceptualised as a teachable moment,  
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3 particularly in relation to smoking cessation.<sup>1,2,3,4,5,6,7,8,9,10</sup> Conceptualising health  
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5 events as teachable moments may be appealing to policymakers and clinicians because they  
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7 represent an opportunity to introduce low-intensity interventions to change modifiable risk  
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9 health-related behaviours to prevent disease and a recent review has identified 9 lifestyle  
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11 interventions at the point of cancer screening to take advantage of this health event as a  
12  
13 teachable moment , including 2 studies of a multiple lifestyle intervention offered to people  
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15 who had undergone colonoscopy and had adenomas removed.<sup>44,45</sup>  
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20 For future research, developing and testing the effect of low intensity interventions (e.g.,  
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22 self-efficacy enhancement) to further reduce alcohol consumption may be appropriate  
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24 because patients appear to spontaneously reduce alcohol consumption following  
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26 colonoscopy, whereas more intense interventions may be required for health-related  
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28 behaviours that do not change (e.g., diet) or change for the worse (e.g., physical activity).  
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30 Qualitative to understand why patients spontaneously change some health behaviours but  
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32 not others following a major health event will add to understanding about the utility of  
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34 teachable moments for public health.  
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41 <sup>1</sup> McBride CM, Emmons KM, Lipkus IM. Understanding the potential of teachable moments:  
42  
43 the case of smoking cessation. *Health Educ Res* 2003;**18(2)**:156-70.

44  
45 <sup>2</sup> Gritz ER, Fingeret MC, Vidrine DJ, et al. Successes and failures of the teachable moment:  
46  
47 smoking cessation in cancer patients. *Cancer* 2006;**106(1)**:17-27.

48  
49 <sup>3</sup> Sharp L, Johansson H, Fagerström K, et al. Smoking cessation among patients with head  
50  
51 and neck cancer: cancer as a 'teachable moment. *Eur J of Cancer Care(Engl)* 2008; **17(2)**:114-  
52  
53 119doi:10.1111/j.1365-2354.2007.00815.x.  
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4<sup>4</sup> McBride CM, Ostroff JS. Teachable moments for promoting smoking cessation: the context  
5  
6 of cancer care and survivorship. *Cancer Control* 2003;**10(4)**:325-33.  
7
- 8<sup>5</sup> Simmons VN, Vidrine JI, Brandon TH. Smoking cessation counseling as a teachable moment  
9  
10 for skin cancer prevention: pilot studies. *Am J Health Behav* 2008;**32(2)**:137-45.  
11
- 12<sup>6</sup> Pollak KI, Denman S, Gordon KC, et al. Is pregnancy a teachable moment for smoking  
13  
14 cessation among US Latino expectant fathers? A pilot study. *Ethn Health* 2010;**15(1)**:47-59.  
15
- 16<sup>7</sup> Shi Y, Warner DO. Surgery as a teachable moment for smoking cessation. *Anesthesiology*  
17  
18 2010;**112(1)**:102-7doi:10.1097/ALN.0b013e3181c61cf9.  
19
- 20<sup>8</sup> Phelan S. Pregnancy: a “teachable moment” for weight control and obesity prevention. *Am*  
21  
22 *J of Obstet Gynecol* 2010;**202(2)**:135.e1-8doi:10.1016/j.ajog.2009.06.008.  
23
- 24<sup>9</sup> Shi L, Iguchi MY. ‘Risk homeostasis’ or ‘teachable moment’? the interaction between  
25  
26 smoking behavior and lung cancer screening in the Mayo Lung Project. *Tob Indu Dis*  
27  
28 2011;**9(1)**:2doi:10.1186/1617-9625-9-2.  
29
- 30<sup>10</sup> Dohnke B, Ziemann C, Will KE, et al. Do hospital treatments represent a ‘teachable  
31  
32 moment’ for quitting smoking? A study from a stage-theoretical perspective. *Psychol and*  
33  
34 *Health* 2012;**27(11)**:1291-307doi:10.1080/08870446.2012.672649.  
35
- 36<sup>11</sup> Lawson PJ, Flocke SA. Teachable moments for health behavior change: A concept analysis.  
37  
38 *Patient Educ and Couns* 2009;**76(1)**:25-30doi:10.1016/j.pec.2008.11.002.  
39
- 40<sup>12</sup> Robb KA, Power E, Kralj-Hans I, Atkin WS, Wardle J. The impact of individually-tailored  
41  
42 lifestyle advice in the colorectal cancer screening context: a randomised pilot study in North-  
43  
44 West London. *Prev Med* 2010 Dec;**51(6)**:505-8. doi: 10.1016/j.ypmed.2010.10.002. Epub  
45  
46 2010 Oct 13.  
47
- 48<sup>13</sup> Williams K, Steptoe A, Wardle J. Is a cancer diagnosis a trigger for health behaviour  
49  
50 change? Findings from a prospective, population-based study. *British J Cancer* 2013;**108**:  
51  
52 2407–2412. doi: 10.1038/bjc.2013.254  
53  
54  
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- <sup>14</sup> Lemon SC, Zapka JG, Clemow L. Health behavior change among women with recent familial diagnosis of breast cancer. *Prev Med*. 2004 Aug;39(2):253-62.
- <sup>15</sup> NHS Atlas of Variation in Healthcare 2011. CANCERS AND TUMOURS. Map 1: Rate of colonoscopy procedures and flexisigmoidoscopy procedures per population by PCT. [http://www.rightcare.nhs.uk/atlas/downloads/CancerMaps\\_AoV\\_2011.pdf](http://www.rightcare.nhs.uk/atlas/downloads/CancerMaps_AoV_2011.pdf) Accessed 4/6/13.
- <sup>16</sup> DH Knowledge & Intelligence Team, *Further Analysis of HES Endoscopy Data*, 2010.
- <sup>17</sup> <http://www.dh.gov.uk/en/Publicationsandstatistics/Statistics/Performedataandstatistics/index.htm> Accessed 24.09.12.
- <sup>18</sup> McBride CM, Puleo E, Pollak KI, et al. Understanding the role of cancer worry in creating a 'teachable moment' for multiple risk factor reduction. *Soc Sci Med* 2008; **66(3)**:790-800.
- <sup>19</sup> Glanz K, Lewis FM, Rimer BK. "Health Behavior and Health Education" (2002) [ISBN 0-7879-5715-1](https://doi.org/10.1002/9780471571511)
- <sup>20</sup> Bandura A. *Self-efficacy: The exercise of control*. 1997; New York: WH Freeman and Company.
- <sup>21</sup> Rogers RW. A protection motivation theory of fear appeals and attitude change. *Journal of Psychology*. 1975;91:93-114.
- <sup>22</sup> <http://www.ipaq.ki.se/downloads.htm> Accessed 11/01/2013.
- <sup>23</sup> Craig C L, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* 2003; **35(8)**: 1381-95.
- <sup>24</sup> <http://www.foodfrequency.org.uk> Accessed 11/01/2013.
- <sup>25</sup> Masson LF, McNeill G, Tomany JO, et al. Statistical approaches for assessing the relative validity of a food frequency questionnaire: use of correlation coefficients and the kappa statistic. *Public Health Nutr* 2003; **6(3)**:313-21.
- <sup>26</sup> <http://www.who.int/dietphysicalactivity/en/> Accessed 11/01/2013.

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- <sup>27</sup> World Cancer Research Fund / American Institute for Cancer Research. Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective. Washington DC: AICR, 2007.
- <sup>28</sup> <http://www.scotland.gov.uk/Topics/Health/health/19133/17756>. Accessed 18/11/2009.
- <sup>29</sup> <http://www.scotland.gov.uk/Topics/Health/health/Alcohol/measures>. Accessed 18/11/2009.
- <sup>30</sup> <http://www.scotland.gov.uk/Topics/Health/health/Introduction>. Accessed 18/11/2009.
- <sup>31</sup> <http://simd.scotland.gov.uk/publication-2012/> Accessed 11/01/2013.
- <sup>32</sup> Wallston KA. The validity of the multidimensional health locus of control scales. *J Health Psychol* 2005;**10(5)**:623-31.
- <sup>33</sup> Wallston KA, Wallston BS, DeVellis R. Development of the Multidimensional Health Locus of control (MHLC) Scales. *Health Educ Monogr* 1978; **6(2)**:160-70.
- <sup>34</sup> [http://userpage.fu-berlin.de/%7Ehealth/faq\\_gse.pdf](http://userpage.fu-berlin.de/%7Ehealth/faq_gse.pdf) Accessed 11/01/2013.
- <sup>35</sup> Satia JA, Campbell MK, Galanko JA, et al. Longitudinal changes in lifestyle behaviours and health status in colon cancer survivors. *Cancer Epidemiol Biomarker Prev* 2004;**13(6)**:1022-31.
- <sup>36</sup> van der Aalst CM, van Klaveren RJ, de Koning HJ. Does participation to screening unintentionally influence lifestyle behavior and thus lifestyle-related morbidity? *Best Pract Res Clin Gastroenterol* 2010;**24(4)**:465-78doi:10.1016/j.bpg.2010.06.001.
- <sup>37</sup> Scottish Government, *The Scottish Health Survey: Summary of Key Findings*, Scottish Government, Edinburgh, 2012.
- <sup>38</sup> Hepper NG, Drage CW, Davies SF, et al. Chronic obstructive pulmonary disease: a community-oriented program including professional education and screening by a voluntary health agency. *Am Rev Respir Dis* 1980; **121(1)**:97-104.
- <sup>39</sup> Ostroff JS, Buckshee N, Mancuso CA, et al. Smoking cessation following CT screening for early detection of lung cancer. *Prev Med* 2001; **33(6)**:613-21.

1  
2  
3  
4<sup>40</sup> Brener ND, Billy JO, Grady WR. Assessment of Factors Affecting the Validity of Self-  
5  
6 Reported Health-Risk Behavior Among Adolescents: Evidence From the Scientific Literature.  
7  
8 *J Adolesc Health* 2003;**33(6)**:436–57.

9  
10  
11<sup>41</sup> <http://www.healthscotland.com/topics/settings/health/index.aspx#hphs> Accessed  
12  
13 19/01/2013.

14  
15<sup>42</sup> Backer V, Nelbom BM, Duus BR, et al. Introduction of new guidelines for emergency  
16  
17 patients: motivational counseling among smokers. *Clin Respir J* 2007;**1(1)**:37-41doi:  
18  
19 10.1111/j.1752-699X.2007.00006.x.

20  
21  
22<sup>43</sup> Bernstein SL, Boudreaux ED, Cydulka RK, et al. Tobacco control interventions in the  
23  
24 emergency department: A joint statement of emergency medicine organizations. *Ann Emerg*  
25  
26 *Med* 2006;**48(4)**:e417-26.

27  
28  
29<sup>44</sup> Anderson A; Promoting changes in diet and physical activity in breast and colorectal  
30  
31 cancer screening settings: *Cancer Prevention research* 2013;**6(3)**:165-72.

32  
33<sup>45</sup> Stead M, Eadie D, Caswell S, Craigie A Anderson AS and the BeWELL team (2012).  
34  
35 Understanding the potential and challenges of adenoma treatment as a prevention  
36  
37 opportunity: insights from the BeWEL formative study *Prev Med* 2012;**54(1)**:97-103.  
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#### 49 50 51 **Registrations**

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**Study hypothesis:** The study hypothesis that major health events are teachable moments triggering spontaneous health-related behaviour change arose before inspection of the data. The main hypothesis was that colorectal cancer diagnosis is a teachable moment. This

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4 article reports a further study hypothesis, which was that colonoscopy is a teachable  
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10 **Data sharing statement:** The relevant anonymised patient level data are available on  
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12 reasonable request from the corresponding author. Participant consent was not obtained  
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14 but the presented data are anonymised and risk of identification is low.  
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Figure 1: Recruitment of participants

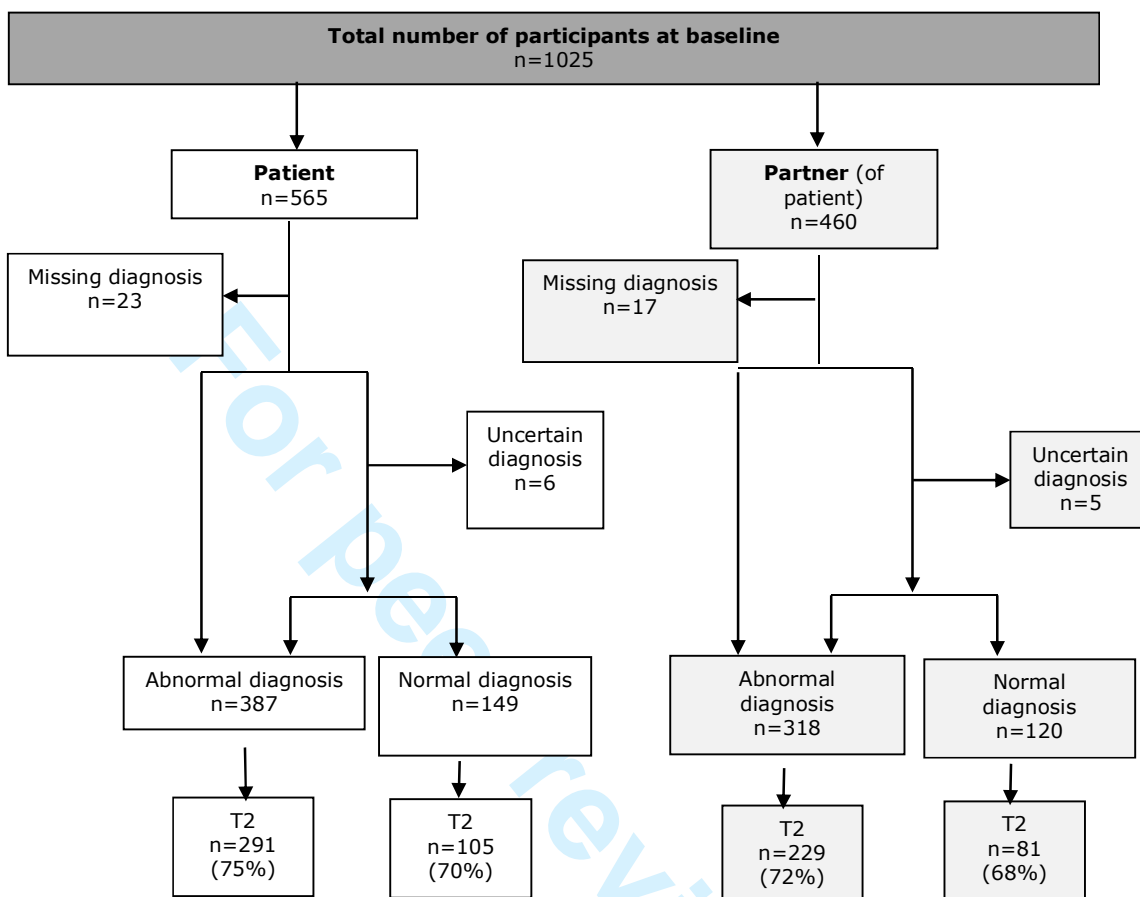


Table 1. Patient and partner baseline characteristics.

	Patients (n=536)			p <sup>1</sup>	Partners of patients (n=438)		
	All (n=536)	ARN (n=387)	NRN (n=149)		ARN (n=318)	NRN (n=120)	p <sup>2</sup>
<b>Sex: Male</b>	308 (57)	236 (61)	72 (48)	<b>0.008</b>	121 (38)	56 (47)	0.101
Female	228 (43)	151 (39)	77 (52)		197 (62)	64 (53)	
<b>Age (years): mean ± SE</b>	60.8 ± 0.5	62.1 ± 0.6	57.6 ± 1.1	<b>&lt;0.001</b>	62.0 ± 0.6	56.8 ± 1.2	<b>&lt;0.001</b>
<b>SIMD quintile:</b>							
1 (most deprived)	41 (8)	31 (8)	10 (7)	0.979	26 (9)	9 (8)	0.425
2	76 (14)	56 (15)	20 (14)		40 (13)	9 (8)	
3	91 (17)	65 (17)	26 (18)		48 (16)	25 (22)	
4	131 (25)	93 (25)	38 (26)		78 (26)	28 (24)	
5 (least deprived)	186 (35)	134 (35)	52 (36)		113 (37)	44 (38)	
<b>Highest level of education:</b>							
School completed	282 (53)	208 (54)	74 (50)	0.578	171 (54)	51 (43)	0.092
College/University	197 (37)	137 (35)	60 (40)		120 (38)	55 (46)	
Postgrad degree completed	57 (11)	42 (11)	15 (10)		26 (8)	14 (12)	
<b>Employment status:</b>							
Self-employed/paid emp.	231 (43)	153 (40)	78 (52)	<b>0.010</b>	128 (41)	71 (59)	<b>0.001</b>
Not employed	14 (3)	11 (3)	3 (2)		3 (1)	5 (4)	
Retired from paid work	252 (47)	196 (51)	56 (38)		154 (49)	38 (32)	
Looking after family-home	22 (4)	12 (3)	10 (7)		24 (8)	4 (3)	
Long term sick or disabled	15 (3)	13 (3)	2 (1)		7 (2)	2 (2)	
<b>Household income:</b>							
Under £20,000	138 (30)	108 (32)	30 (25)	<b>0.040</b>	85 (31)	29 (28)	<b>0.002</b>
£20,000-29,999	99 (21)	79 (23)	20 (17)		71 (26)	12 (12)	
£30,000-39,00	60 (13)	46 (13)	14 (12)		43 (16)	13 (13)	
£40,000-49,000	61 (13)	42 (12)	19 (16)		25 (9)	13 (13)	
£50,000 and above	104 (23)	66 (19)	38 (31)		53 (19)	37 (36)	
<b>Physical activity</b> (MET-minutes/week)		4152 [1997, 7668]	4381 [2157, 7338]	0.801	4250 [1980, 8406]	4134 [1964, 8178]	0.917
<b>Risk behaviour</b>							
1. <5 measures/day of fruit & vegetables	93 (27)	70 (28)	23 (25)	0.493	62 (29)	20 (27)	0.764
2. <3 measures/day of bread & consume white bread only	75 (15)	54 (15)	21 (15)	0.989	49 (16)	12 (10)	0.126
3. >4 (men) & >3 (women) units/day of alcohol	88 (20)	67 (22)	21 (17)	0.267	36 (14)	26 (28)	0.002
4. Current smoker	54 (11)	36 (10)	18 (13)	0.320	36 (12)	19 (17)	0.169
5. Low physical activity level	203 (50)	159 (54)	44 (40)	0.009	135 (53)	40 (41)	0.050
6. Obese (BMI≥30.0 kg/m <sup>2</sup> )	92 (21)	70 (23)	22 (18)	0.355	44 (19)	25 (26)	0.205

**Risk behaviour score group**

1 or less	154 (48)	102 (45)	52 (58)	0.026	88 (45)	31 (44)	0.930
2 or more	164 (52)	127 (55)	37 (42)		108 (55)	39 (56)	

<sup>1</sup>P-value for difference between patients; <sup>2</sup>P-value for difference between partners

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**Table 1: Self-efficacy and multidimensional health locus of control scores at baseline (ARN and NRN patients and their partners): median [IQR]**

	Patients		p <sup>1</sup>	Partners of patients		p <sup>2</sup>
	ARN (n=387)	NRN (n=149)		ARN (n=318)	NRN (n=120)	
<b>Smoking cessation self-efficacy<sup>3</sup></b>						
Score (range 5 - 20)	12 [9, 16]	13 [9, 18]	0.355	11 [9, 14]	10 [7, 12]	0.055
Low (5 - 12): n (%)	20 (51)	8 (42)	0.512	20 (54)	14 (82)	<b>0.045</b>
High (13 - 20): n (%)	19 (49)	11 (58)		17 (46)	3 (18)	
<b>Physical activity self-efficacy</b>						
Score (range 5 - 20)	14 [11, 15]	14 [12, 18]	0.073	14 [11, 17]	14 [10, 16]	0.948
Low (5 - 14): n (%)	205 (55)	76 (52)	0.530	163 (53)	65 (56)	0.588
High (15 - 20): n (%)	167 (45)	70 (48)		144 (47)	51 (44)	
<b>Diet self-efficacy</b>						
Score (range 5 - 20)	15 [14, 18]	15 [14, 20]	0.121	15 [14, 19]	15 [12, 20]	0.875
Low (5 - 15): n (%)	230 (62)	84 (59)	0.566	191 (62)	73 (64)	0.731
High (16 - 20): n (%)	144 (39)	59 (41)		116 (38)	41 (36)	
<b>Alcohol resistance self-efficacy</b>						
Score (range 3 - 12)	9 [7, 12]	10 [7, 12]	0.657	11 [8, 12]	10 [7, 12]	0.530
Low (3 - 10): n (%)	187 (55)	71 (55)	0.956	133 (48)	55 (51)	0.511
High (11 - 12): n (%)	151 (45)	58 (45)		146 (52)	52 (49)	
<b>MHLC Internal</b>						
Score (range 6 - 36)	25 [22, 28]	26 [21, 29]	0.381	26 [22, 28]	26 [22, 29]	0.696
Low (6 - 25): n (%)	203 (53)	72 (49)	0.415	152 (48)	59 (50)	0.783
High (26 - 36): n (%)	183 (47)	76 (51)		164 (52)	60 (50)	
<b>MHLC Chance</b>						
Score (range 6 - 36)	17 [13, 21]	17 [13, 21]	0.335	18 [14, 22]	17 [13, 22]	0.788
Low (6 - 17): n (%)	197 (51)	83 (56)	0.332	154 (49)	61 (51)	0.638
High (18 - 36): n (%)	189 (49)	66 (44)		162 (51)	58 (49)	
<b>MHLC Powerful others</b>						
Score (range 6 - 36)	18 [14, 23]	17 [12, 21]	<b>0.032</b>	18 [13, 22]	15 [11, 20]	<b>0.018</b>
Low (6 - 17): n (%)	186 (48)	77 (52)	0.442	154 (49)	75 (63)	<b>0.008</b>
High (18 - 36): n (%)	199 (52)	71 (48)		162 (51)	44 (37)	

<sup>1</sup>P-value for difference between patients

<sup>2</sup>P-value for difference between partners

<sup>3</sup>Current smokers only

Table 1: Change in patient risk behaviours between T1 and T2: n (%)

	All patients (n=418)*			ARN (n=387)		NRN (n=149)			
	T1	T2	p <sup>1</sup>	T1	T2	p <sup>1</sup>	T1	T2	p <sup>2</sup>
<b>Risk behaviour</b>									
<5 measures/day of fruit & vegetables	38 (23)	40 (24)	0.845	28 (24)	30 (26)	0.815	9 (20)	7 (15)	0.687
<3 measures/day of bread & consume white bread only	46 (12)	43 (11)	0.766	34 (13)	30 (11)	0.585	11 (11)	10 (10)	1.000
>4 (men) & >3 (women) units/day of alcohol	58 (21)	45 (16)	<b>0.047</b>	41 (22)	31 (17)	0.064	14 (17)	13 (16)	1.000
Current smoker	27 (8)	24 (7)	0.250	15 (6)	13 (5)	0.500	10 (10)	9 (9)	1.000
Low physical activity level	131 (50)	150 (58)	<b>0.004</b>	98 (54)	112 (61)	<b>0.013</b>	25 (40)	29 (46)	0.388
Obese (BMI≥30.0 kg/m <sup>2</sup> )	56 (19)	64 (22)	0.152	43 (21)	49 (24)	0.238	10 (14)	11 (15)	1.000
<b>Risk behaviour score group</b> (number of risk behaviours)									
1 or less	84 (54)	80 (51)	0.572	52 (49)	47 (44)	0.359	29 (67)	30 (70)	1.000
2 or more	73 (47)	77 (49)		55 (51)	60 (56)		14 (33)	13 (30)	

<sup>1</sup>P-value for difference between T1 and T2 in patients with an abnormal diagnosis

<sup>2</sup>P-value for difference between T1 and T2 in patients with a normal diagnosis

\* Includes patients with missing diagnosis.

Table 1: Predictors of low physical activity at T2 in patients (n=268)

	Odds Ratio	95% CI	P
Low PA at T1 (versus high)	26.2	(9.57, 71.7)	<b>&lt;0.001</b>
Age (years)	1.07	(1.02, 1.12)	<b>0.005</b>
Female sex (versus male)	0.73	(0.29, 1.81)	0.495
SIMD Quintile			
1	1.00		
2	0.98	(0.14, 6.67)	0.981
3	1.65	(0.23, 11.8)	0.618
4	4.93	(0.77, 31.6)	0.093
5	1.70	(0.29, 10.1)	0.558
Any medical conditions (versus none)	1.13	(0.44, 2.93)	0.801
ARN (versus NRN)	1.17	(0.44, 3.13)	0.749
Raw MHLC Internal score	0.96	(0.88, 1.05)	0.421
Raw MHLC Chance score	0.99	(0.91, 1.07)	0.775
Raw MHLC Powerful others score	1.06	(0.98, 1.15)	0.126
Raw Physical activity self-efficacy score	0.99	(0.96, 1.02)	0.517
Raw Time spent sitting per day (including motor vehicle)	1.00	(0.99,1.00)	0.922
Constant	0.004	(0.00, 0.26)	0.009

Table 1: Predictors of high alcohol intake at T2 in patients (n=232)

	Odds Ratio	95% CI	P
>4(men) & >3 (women) units/day alcohol at T1	12.4	(4.83, 31.5)	<b>&lt;0.001</b>
Age (years)	0.99	(0.95, 1.03)	0.601
Female sex (versus male)	1.02	(0.39, 2.63)	0.975
SIMD Quintile			
1	1.00		
2	4.87	(0.48, 49.5)	0.181
3	3.23	(0.33, 31.5)	0.313
4	1.23	(0.15, 10.1)	0.847
5	1.96	(0.24, 15.8)	0.525
Any medical conditions (versus none)	0.66	(0.23, 1.89)	0.441
Abnormal diagnosis (versus normal)	0.83	(0.29, 2.34)	0.725
Raw MHLC Internal score	1.00	(0.92, 1.08)	0.988
Raw MHLC Chance score	0.97	(0.88, 1.07)	0.556
Raw MHLC Powerful others score	1.00	(0.93, 1.08)	0.905
Raw Alcohol self-efficacy score	0.70	(0.58, 0.84)	<b>&lt;0.001</b>
Constant	3.74	(0.04, 360.3)	0.572

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STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Article
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Y
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Y
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Y
Objectives	3	State specific objectives, including any prespecified hypotheses	Y
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	Y
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Y
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Y
		(b) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Y
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Y
Bias	9	Describe any efforts to address potential sources of bias	Y
Study size	10	Explain how the study size was arrived at	Y
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Y
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Y
		(b) Describe any methods used to examine subgroups and interactions	NA
		(c) Explain how missing data were addressed	Y
		(d) If applicable, explain how loss to follow-up was addressed	Y
		(e) Describe any sensitivity analyses	NA
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Y
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	Y
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Y
		(b) Indicate number of participants with missing data for each variable of interest	Y
		(c) Summarise follow-up time (eg, average and total amount)	-
Outcome data	15*	Report numbers of outcome events or summary measures over time	NA
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear	Y

		which confounders were adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	Y
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	Y
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Y
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Y
Generalisability	21	Discuss the generalisability (external validity) of the study results	Y
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Y

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.



**Do health behaviours change after colonoscopy? A prospective cohort study on diet, alcohol, physical activity and smoking among patients and their partners.**

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2013-003706.R1
Article Type:	Research
Date Submitted by the Author:	16-Oct-2013
Complete List of Authors:	Hubbard, Gill; University of Stirling, School of Nursing, Midwifery and Health Brown, Alistair; NHS Lanarkshire, Hairmyres Hospital Campbell, Anna; Dundee University, Institute Sport and Exercise Campbell, Neil; University of Aberdeen, General Practice and Primary Care Diament, Robert; NHS Ayrshire and Arran, Crosshouse hospital Fielding, Shona; University of Aberdeen, Division of Applied Health Sciences Forbat, Liz; University of Stirling, Nursing, Midwifery and Health Masson, Lindsey; Lovely Nutrition Ltd, O'carroll, Ronan; University of Stirling, Psychology Stein, Kevin; American Cancer Society, Behavioral Research Centre Morrison, David; Glasgow University, Institute of Health and Well-being
<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Epidemiology, Public health, Gastroenterology and hepatology
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, Endoscopy < GASTROENTEROLOGY

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Manuscripts

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7 **Do health behaviours change after colonoscopy? A prospective cohort study on diet,**  
8 **alcohol, physical activity and smoking among patients and their partners.**  
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12 **Authors:** Gill Hubbard,<sup>1\*</sup> Alistair Brown,<sup>2</sup> Anna Campbell,<sup>3</sup> Neil Campbell,<sup>4</sup> Bob Diament,<sup>5</sup>  
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28 **Words:** colorectal neoplasms, colonoscopy, behavior, diet  
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32 **Word count:** 2,679  
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**ABSTRACT****Objectives**

We hypothesised that colonoscopy triggers changes for the better in health behaviours. Our objective was to describe diet, alcohol, physical activity and tobacco use prospectively i.e. before and 10 months after colonoscopy for patients and their partners.

**Design**

Prospective cohort study of health behaviour change in patients and their partners before and 10 months after colonoscopy. Comparison groups are patients receiving a normal result notification (NRN) versus patients receiving an abnormal result notification (ARN) such as, colorectal cancer, polyps or diverticulitis. Health behaviour change of patients and partners (controls) are also compared.

**Setting**

5 Scottish hospitals.

**Participants**

Of 5,798 colonoscopy registrations, 2,577 (44%) patients met eligibility criteria of whom 565 (22%) were recruited; 460 partners were also recruited.

**Measures**

International Physical Activity Questionnaire, Scottish Collaborative Group Food Frequency Questionnaire (includes alcohol), smoking status, age, sex, education, household income,

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3 employment status, Scottish Index of Multiple Deprivation (SIMD), Body Mass Index,  
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5 medical conditions, result of the colonoscopy (ARN or NRN), Multidimensional Health Locus  
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7 of Control Scale (MHLC), behaviour-specific self-efficacy scales.  
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## 11 Results

12  
13 57% of patients were male, mean age 60.8 years (SE 0.5) and 43% were from more affluent  
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15 areas. 72% (n=387) of patients received an ARN and 28% (n=149) a NRN. Response rate to  
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17 the second questionnaire at 10 months was 68.9%. Overall, 27% of patients consumed less  
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19 than 5 measures of fruit & vegetables per day, 20% exceeded alcohol limits, 50% had low  
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21 levels of physical activity and 21% were obese. At 10 month follow-up, a 5% reduction in  
22  
23 excessive alcohol consumption and an 8% increase in low levels of physical activity were  
24  
25 observed among patients; no significant behavioural changes occurred in their partners.  
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28 Baseline high alcohol consumption and low physical activity were the strongest predictors of  
29  
30 these behaviours at follow-up. Additionally, low alcohol self-efficacy and increasing age  
31  
32 were associated with poorer health-related behaviours at follow-up for alcohol and physical  
33  
34 activity, respectively.  
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## 40 Conclusions

41  
42 Colonoscopy can be regarded as a teachable moment for patients, being associated with  
43  
44 marginal beneficial changes in some health behaviours. Yet, colonoscopy is also associated  
45  
46 with negative changes in health behaviours. Further work is needed to explore how services  
47  
48 can optimize increases in beneficial health behaviours and mitigate increases in harmful  
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50 ones.  
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## Article summary

### Article focus

- Colonoscopy is an increasingly common investigation that might trigger spontaneous behavioural changes in patients.
- Little is known about health behaviour change following colonoscopy, particularly in the UK.
- We carried out a prospective cohort study of patients who underwent colonoscopy and their partners.

### Key messages

- There is a high prevalence of unhealthy behaviours in colonoscopy patients.
- We observed marginal but statistically significant reductions in excessive alcohol consumption but also decreases in physical activity following colonoscopy.
- There may be opportunities to encourage spontaneous improvements in health behaviours among colonoscopy patients and to mitigate harmful behaviours.

### Strengths and limitations of this study

- This is the first prospective cohort study on health behaviours in colonoscopy patients in the UK.
- We obtained a large sample size and high follow-up rate and were able to use



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3 patients' partners as controls.  
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- 5 • Selection biases may have led to our sample comprising healthier patients than in  
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7 the general colonoscopy population.  
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## INTRODUCTION

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Illnesses and interactions with health services may motivate patients to change their health behaviours for the better. Such “teachable moments” have been described for changes in smoking behaviour following life transitions, such as pregnancy, and health events, such as screening for lung cancer.<sup>1,2,3,4,5,6,7,8,9,10</sup> A recent review of the literature concludes that while the term “teachable moment” is used imprecisely – to describe either an opportunity for behavioural change or an event associated with actual change - there is evidence that beneficial behavioural changes can be actively created through appropriate clinician-patient interactions.<sup>11</sup> To our knowledge, evidence from the UK that patients who undergo screening for cancer are likely to make improvements in health behaviour is limited to a single pilot study of a health promotion intervention delivered during colorectal cancer screening.<sup>12</sup> The evidence from UK observational research that there are spontaneous health behaviour changes after a cancer diagnosis is limited to analyses of population surveys that depend on self-reported cancer diagnosis and found little evidence that a cancer diagnosis motivates health-protective changes.<sup>13</sup> Relatives of cancer patients may also change their behaviour in response to a familial diagnosis, but the evidence is limited to one study on breast cancer.<sup>14</sup>

Colonoscopy is mainly performed for the diagnosis of colon and rectal cancer and current UK rates of 80 procedures per 10,000 population are likely to increase in the future as screening by flexible sigmoidoscopy is introduced.<sup>15</sup> The number of colonoscopies performed through the Scottish bowel screening programme almost doubled from 5,358 in 2009 to 9,296 in 2011; in England, 368,162 colonoscopies were carried out in 2009-10.<sup>16,17</sup> We hypothesised

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3 that colonoscopy represents both concepts of a teachable moment for beneficial health  
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5 behaviour change: it may be a time of concern about a cancer diagnosis and thus be  
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7 associated with spontaneous change,<sup>1-18</sup> and it may also present an opportunity for  
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9 clinicians to promote improvements in behaviours. An abnormal colonoscopy result may be  
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11 more likely to trigger beneficial changes in behaviour, so we compared behaviours between  
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13 participants with normal and abnormal test results. Our aim was to describe health-related  
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15 behaviours before and after a colonoscopy among patients and their partners. Our  
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17 objective was to carry out a prospective observational study on colonoscopy patients and  
18  
19 their partners using self-reported questionnaire survey data immediately before and ten  
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21 months after colonoscopy. As self-efficacy and locus of control are central to several health  
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23 behaviour theories, including the Health Belief Model,<sup>19</sup> Social Cognitive Theory<sup>20</sup> and  
24  
25 Protection Motivation Theory,<sup>21</sup> we assessed their roles using validated questionnaires and  
26  
27 also recorded physical activity, tobacco smoking, diet and alcohol consumption. We  
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29 hypothesised that study participants with high scores of self-efficacy and with 'internal'  
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31 locus of control would change health behaviours for the better following colonoscopy.  
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33 Although there is no cut-off score to define persons as being high or low self-efficacious  
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35 Ralph Schwarzer, an expert in self-efficacy measurement, recommends conducting a median  
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37 split, which is to dichotomize the study sample.<sup>35</sup> 'Health-Internals' believe that the locus of  
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39 control for health is internal and that one stays or becomes healthy or sick as a result of his  
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41 or her behaviour whereas 'health-externals' believe that factors which determine their  
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43 health are such things as 'powerful others' and 'chance' over which they have little control.  
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## 50 **METHODS**

### 51 **Study design**

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3 We conducted a prospective cohort study of health behaviour change in patients and their  
4 partners before and 10 months after colonoscopy. Comparison groups are patients  
5 receiving a normal result notification (NRN) versus patients receiving an abnormal result  
6 notification (ARN) such as, colorectal cancer, polyps or diverticulitis. Health behaviour  
7 change of patients and partners (controls) are also compared.  
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### 13 14 15 16 **Setting**

17 Colonoscopy clinics in five hospitals within three Health Board areas in Scotland, UK.  
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19 Recruitment occurred between September 2010 and August 2011.  
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### 24 25 **Participants**

26 Patients were invited by an advert for the study enclosed along with their colonoscopy  
27 appointment letter from the hospital. On attendance for colonoscopy, clinic staff obtained  
28 verbal consent for patients (and, if present, their partners) to allow the Research Assistant  
29 (RA) to approach them. If a patient did not wish to be approached by the RA, consent was  
30 sought to retain non-identifiable data (age, sex and sector level of the postcode) to assess  
31 selection bias. The RA asked consenting participants to complete the baseline (T1)  
32 questionnaire and written consent form at home and return both in a pre-paid addressed  
33 envelope. Patients whose partners were not present were asked to provide the name and  
34 contact details of their partner who was subsequently contacted by the RA by telephone  
35 about the study.  
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### 50 51 **Eligibility criteria**

52 Patient inclusion criteria were: i) referred for colonoscopy, ii) no past history of cancer, iii)  
53 ≥18 years old, iv) has a partner. Partner inclusion criteria: i) ≥18 years old, ii) no history of  
54 cancer.  
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### Primary outcome

The primary outcome measure was the extent of change in individual health behaviours before colonoscopy and 10 months later. Consequently, we selected measures that ranked individuals along a distribution of amount of physical activity, dietary and alcohol intake, and tobacco use.

### Variables, measures and data sources

Information was self-reported by participants or obtained from medical records.

#### Health-related behaviour variables

The International Physical Activity Questionnaire<sup>22,23</sup> was used to categorise participants into low, moderate or high levels of PA using Metabolic Equivalent of Task (MET) scores. The Scottish Collaborative Group Food Frequency Questionnaire (SCG FFQ)<sup>24,25</sup> was used to measure intakes of foods and alcohol. Current smokers were defined as those who had smoked at least 100 cigarettes in their entire life and currently smoked.

An aggregate risk behaviour score was calculated based on generally accepted requirements for risk factor reduction for most of the main chronic diseases and specifically for prevention of colorectal cancer because colonoscopy is a main investigation for colorectal cancer symptoms.<sup>26,27</sup> Specifically, we defined high risk behaviour using Scottish government recommendations<sup>28,29</sup>, as follows: <5 measures/day of fruit and vegetables; <3 portions/day of bread; >4 (men) and >3 (women) units/day of alcohol; current smoker; and low physical activity (equivalent to less than thirty minutes of moderate intensity activity on at least 4 days of the week). For the purpose of this study, a 'measure' as defined in the SCG FFQ was assumed to be equal to a 'portion' of fruit or vegetables.

### Demographic variables

Participants self-reported their age, sex, level of education, household income, employment status, and postcode (to calculate Scottish Index Multiple Deprivation (SIMD<sup>30</sup>)).

### Clinical variables

Body Mass Index (BMI) was calculated by dividing weight (kg) by height squared (m<sup>2</sup>) using self-reported values. Participants were categorised as obese if BMI $\geq$ 30.0 kg/m<sup>2</sup>. Participants self-reported their medical conditions currently being treated by a doctor. Result of the colonoscopy was obtained from patient medical records. Patients were categorised as receiving a normal result notification (NRN) or abnormal result notification (ARN) such as, colorectal cancer, polyps or diverticulitis.

### Psychological variables

Participants' perceived control over their health-related behaviours was measured using the Multidimensional Health Locus of Control Scale<sup>31,32</sup>. The instrument measures three dimensions of control: internal, powerful others and chance. Participants' self-efficacy was measured using four separate self-efficacy scales (smoking, diet, alcohol, PA) recommended by Schwarzer and colleagues.<sup>33</sup> There is no cut-off score to define persons as being high or low self-efficacious so we split the sample at the median, as recommended by Schwarzer.<sup>34</sup>

### Data collection

The baseline (T1) questionnaire was administered to patients who attended a colonoscopy clinic between September 2010 and August 2011. A pre-paid envelope was provided for participants to return the questionnaire after completing it at home. Participants were requested to report health behaviours before colonoscopy. There was no cut-off date for

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3 returning the baseline questionnaire. The follow-up questionnaire (T2) was posted 10  
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5 months after the clinic date for colonoscopy, between July 2011 and June 2012.  
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### 8 9 **Bias**

10 We attempted to minimise information biases by using, where possible, validated  
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12 questionnaires and to minimise selection biases by inviting all colonoscopy patients to  
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14 participate.  
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### 18 19 **Statistical analysis**

20 Statistical analysis was carried out using Stata/SE 11.2 software. Means  $\pm$  standard errors or  
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22 medians [interquartile range (IQR)] were presented as appropriate following visual  
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24 assessment of histograms of continuous variables. Differences in characteristics and  
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26 behaviours between groups were assessed using Pearson's chi-squared test for categorical  
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28 measures and either T-tests or Mann-Whitney tests for continuous variables as appropriate.  
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30 Differences in continuous variables between T1 and T2 were assessed using a paired T-test  
31  
32 or the Wilcoxon signed-rank test. Differences in categorical variables between T1 and T2  
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34 were assessed in SPSS version 20 using the McNemar-Bowker test for variables with 3 or  
35  
36 more categories, and the McNemar test for binary variables. To predict health-related  
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38 behaviour at T2 logistic regression models were undertaken.  
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### 46 47 **Statistical power**

48 Our sample size was based on answering the research question '*Do health behaviours*  
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50 *change after a major health threat?*' We used the variable physical activity to calculate  
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52 statistical power because it has the strongest association with colorectal cancer survival and  
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54 detecting colorectal cancer is one of the main reasons for colonoscopy referral. This paper  
55  
56 reports a comparison of changes in health behaviours of patients with NRN and ARN  
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3 following colonoscopy. However, the study had initially aimed to detect an increase in  
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5 physical activity of 25 or greater MET hours in patients diagnosed with cancer at  
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7 colonoscopy compared to non-cancer patients, and samples of 46 cancer and 46 non-cancer  
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9 patients would have been required. The effect size was derived from Satia,<sup>35</sup> and sample  
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11 size calculations assumed conventional values of  $\alpha=0.05$  and  $\beta=0.20$  (giving a power, or  $1-\beta$ ,  
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13 of 80%). Thus, our study numbers exceeded those required by the initial sample size  
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15 calculation.  
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## 18 19 20 RESULTS

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25 Of 5,798 colonoscopy registrations, 2,577 patients (44%) met eligibility criteria for the study  
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27 of whom 565 (22%) eligible patients and 460 partners were recruited (**Error! Reference**  
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29 **source not found.**). Recruited patients compared to non-recruited patients were  
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31 significantly older ( $60.3 \pm 0.5$  versus  $57.2 \pm 0.4$ ), more affluent (Carstairs decile 1 and 2, 43%  
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33 versus 29%) and a higher proportion male (57% males versus 50% male). 72% (n=387) of  
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35 patients received an ARN and 28% (n=149) a NRN. Overall, 68.9% (n=706) of participants  
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37 returned a second, follow-up questionnaire at T2. The median times for both patients and  
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39 partners to return the baseline questionnaire was 12 days.  
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44 **{Please insert Figure 1 here}**  
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49 At baseline (T1), a higher proportion of patients with abnormal result notification (ARN)  
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51 were male, older, retired, and with a household income under £20,000 compared to  
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53 patients with normal result notification (NRN) - Table 1. Overall 27% consumed less than  
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55 five measures a day of fruit/vegetable, 20% exceeded recommended alcohol limits, 50% had  
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57 low levels of physical activity and 21% were obese. Higher proportions of ARN patients were  
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3 not meeting these recommendations but the difference was only significant for physical  
4 activity. Only 11% of patients reported current smoking. When combined, overall 52% of  
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6 participants had 2 or more risk behaviours, which comprised 55% of ARN and 42% of NRN.  
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11 **{Please insert Table 1 here}**  
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16 There were no significant differences between patients with abnormal and normal results  
17 with respect to self-efficacy for smoking cessation, physical activity, diet and alcohol (Table  
18 2). Partners of patients with normal results were more likely to have low self-efficacy for  
19 smoking cessation.  
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28 **{Please insert Table 2 here}**  
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32 Overall, there was a 5% reduction in respondents who exceeded alcohol consumption  
33 guidance and an 8% increase in the proportion with low physical activity - Table 3. The  
34 proportionate increase in low physical activity was similar in patients with abnormal and  
35 normal colonoscopy results but statistically significant only among those with abnormal  
36 findings (which might be explained by the larger sample size in the abnormal category).  
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38 When risk behaviours were aggregated, there was no overall change in behaviours in any  
39 patient group. We found no significant change in health behaviours of partners, irrespective  
40 of the colonoscopy result of the patient (data not shown).  
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52 **{Please insert Table 3}**  
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3 We used multiple logistic regression analyses to explore predictors of the two behaviours  
4 that changed significantly over time: low physical activity and high alcohol intake - Table 4.  
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7 Low physical activity at baseline was the strongest predictor of low physical activity at T2  
8 among patients and increasing age was also associated with lower physical activity. Sex,  
9 socio-economic circumstances, co-morbidities, colonoscopy findings and self-efficacy did not  
10 predict changes in physical activity over time.  
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18 **{Please insert Table 4}**

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20 Excessive alcohol consumption at T2 was most strongly determined by excessive  
21 consumption at baseline - Table 5. Lower self-efficacy at T1 was associated with higher  
22 alcohol consumption at T2. Age, sex, socio-economic circumstances, co-morbidities and  
23 colonoscopy findings were not associated with higher alcohol intake at follow-up.  
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31 **{Please insert Table 5}**

## 32 33 34 35 **DISCUSSION**

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37 Colonoscopy was associated with marginal spontaneous changes (that is, without a  
38 behavioural intervention) in some health-related behaviours. We found that there was a 5%  
39 reduction in excessive alcohol consumption (a beneficial change) but an 8% increase in low  
40 levels of physical activity (a change for the worse) 10 months after colonoscopy. There  
41 were no significant changes in health behaviours among patients' partners, suggesting that  
42 behavioural changes in colonoscopy patients were not necessarily part of wider trends that  
43 might influence health behaviours. No behavioural advice was given to patients as part of  
44 their investigations, and thus colonoscopy might be regarded as a teachable moment in  
45 which spontaneous changes are triggered. However, colonoscopy also represents an  
46 interaction with health services that might be optimized to encourage improvements in  
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3 health-related behaviours. At baseline, we found that ARN patients and their partners  
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5 scored significantly higher than the NRN patients and partners on the MHLC Powerful Others  
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7 scale, indicating that ARN patients and partners believed more strongly that health  
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9 professionals were responsible for their health and health outcomes. Thus, ARN patients in  
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11 particular, may be receptive to health promotion advice from health professionals.  
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16 Our conclusion that colonoscopy can be regarded as a teachable moment is similar to a  
17  
18 recent systematic review of eleven articles about the impact of cancer screening (nine of  
19  
20 which investigated the impact of lung screening on smoking cessation) which concluded that  
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22 cancer screening 'might' be a teachable moment for health behaviour change<sup>36</sup>. Research  
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24 about change in health behaviours after diagnosis of chronic health conditions indicate at  
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26 best, only modest changes.<sup>37</sup> Thus, based on current evidence it remains uncertain if, and  
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28 the extent to which major health events represent teachable moments. Health behaviours  
29  
30 are likely to be influenced by a complex mix of factors, so that in addition to any beneficial  
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32 teachable moment effects, ongoing symptoms that prompted colonoscopy may also affect  
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34 behaviour. These may explain reductions in high levels of physical activity and concomitant  
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36 increases in low levels.  
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41 We found that baseline health behaviours for low physical activity and excessive alcohol  
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43 consumption were the strongest predictors of the same behaviours 10 months after  
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45 colonoscopy but, additionally, increasing age predicted lower physical activity and lower  
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47 self-efficacy around alcohol predicted excessive alcohol consumption at follow-up. Among  
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49 our patient sample, 11% smoked, which is much lower than the Scottish general adult  
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51 population prevalence of 23%.<sup>38</sup>  
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3 This study found that a low level of PA at the time of colonoscopy and older age were  
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5 predictive of a low level of PA 10 months post-colonoscopy. Further, high alcohol intake at  
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7 the time of colonoscopy and low alcohol self-efficacy were predictive of high alcohol intake  
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9 post-colonoscopy. Of note, fatalism (MHLC Chance score) was not predictive of any  
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11 differential health behavior change. ARN was not predictive of health behaviour change  
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13 following this health event, which is in contrast to studies of smokers under-going screening  
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15 for lung disease.<sup>39,40</sup> A cross-sectional study of over 10,000 smokers at 2-3 years post-  
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17 screening for COPD found that those with a first-time positive result were significantly more  
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19 likely to stop smoking than those with a negative result<sup>39</sup>. A cross-sectional study of 134  
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21 active smokers who underwent spiral CT screening found that 62% of those with a positive  
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23 result either stopped or decreased smoking, whereas only 46% with a negative result did  
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25 so.<sup>40</sup> Thus, the effect of test results following screening for disease on health-related  
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27 behaviour appears to vary according to type of screen (e.g., colonoscopy versus spiral CT),  
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29 reason for screening (e.g., colon disease versus lung disease) and health-related behaviour  
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31 (e.g., alcohol versus smoking).  
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38 Our study has strengths and limitations. This is the first prospective observational study to  
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40 report health-related behaviours of patients and their partners before and 10 months after  
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42 colonoscopy. We used validated questionnaire survey tools, obtained a relatively large  
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44 sample for a prospective cohort study and achieved high follow-up rates of 69%. There are  
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46 however, several study limitations. First, the sample may not be representative of all  
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48 patients population undergoing colonoscopy. The response rate of eligible patients was 22%,  
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50 and there was some selection bias towards a more affluent, older and male population.  
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52 Socio-economic affluence may explain why our sample had lower smoking prevalence than  
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54 the general population. Patients who participate in the newly introduced national colorectal  
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56 cancer screening programme also may be more likely to be motivated to change in their  
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3 behaviour. Second, while participants were requested to self-report health behaviours  
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5 before the colonoscopy and as soon as possible thereafter, the baseline questionnaire was  
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7 completed after the colonoscopy when participants may already have been influenced and  
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9 starting to make some changes and there was no cut-off date for returning the baseline  
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11 questionnaire. Thus, the observed changes for the better or worse in health behaviours may  
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13 be an under-estimation of the extent of change. Third, although valid and reliable survey  
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15 instruments were used, self-reported data are susceptible to expectation biases and other  
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17 misclassification effects.<sup>41</sup> However, our principal interest was in behavioural change rather  
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19 than absolute prevalences of behaviours, and thus over- or under-reporting of certain  
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21 behaviours would not necessarily invalidate our findings on whether they changed after  
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23 colonoscopy. The observed decreases in excessive alcohol consumption and in physical  
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25 activity following colonoscopy may not be caused by the procedure but by other  
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27 confounding factors that we have not identified. We are not aware of any health promotion  
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29 activity associated with colonoscopy as it was delivered within the participating hospitals  
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31 and our questionnaires were designed not to imply any favourable behaviours. The fact that  
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33 there were no observed changes in partners and no differences between ARN and NRN  
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35 patients suggests that the observed behavioural changes in patients was related to the  
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37 colonoscopy.  
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44 Health care settings are recognised as important loci for promoting health behaviour  
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46 change<sup>42,43,44</sup> and health events have been conceptualised as a teachable moment,  
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48 particularly in relation to smoking cessation.<sup>1,2,3,4,5,6,7,8,9,10</sup> Conceptualising health  
49  
50 events as teachable moments may be appealing to policymakers and clinicians because they  
51  
52 represent an opportunity to introduce low-intensity interventions to change modifiable risk  
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54 health-related behaviours to prevent disease and a recent review has identified 9 lifestyle  
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56 interventions at the point of cancer screening to take advantage of this health event as a  
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3 teachable moment , including 2 studies of a multiple lifestyle intervention offered to people  
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5 who had undergone colonoscopy and had adenomas removed.<sup>45,46</sup>  
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9 For future research, developing and testing the effect of low intensity interventions (e.g.,  
10 self-efficacy enhancement) to further reduce alcohol consumption may be appropriate  
11 because patients appear to spontaneously reduce alcohol consumption following  
12 colonoscopy, whereas more intense interventions may be required for health-related  
13 behaviours that do not change (e.g., diet) or change for the worse (e.g., physical activity).  
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15 Qualitative to understand why patients spontaneously change some health behaviours but  
16 not others following a major health event will add to understanding about the utility of  
17 teachable moments for public health.  
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<sup>1</sup> McBride CM, Emmons KM, Lipkus IM. Understanding the potential of teachable moments:  
31 the case of smoking cessation. *Health Educ Res* 2003;**18(2)**:156-70.  
32

33  
34 <sup>2</sup> Gritz ER, Fingeret MC, Vidrine DJ, et al. Successes and failures of the teachable moment:  
35 smoking cessation in cancer patients. *Cancer* 2006;**106(1)**:17-27.  
36

37  
38 <sup>3</sup> Sharp L, Johansson H, Fagerström K, et al. Smoking cessation among patients with head  
39 and neck cancer: cancer as a 'teachable moment. *Eur J of Cancer Care(Engl)* 2008; **17(2)**:114-  
40 119doi:10.1111/j.1365-2354.2007.00815.x.  
41  
42

43  
44 <sup>4</sup> McBride CM, Ostroff JS. Teachable moments for promoting smoking cessation: the context  
45 of cancer care and survivorship. *Cancer Control* 2003;**10(4)**:325-33.  
46  
47

48  
49 <sup>5</sup> Simmons VN, Vidrine JI, Brandon TH. Smoking cessation counseling as a teachable moment  
50 for skin cancer prevention: pilot studies. *Am J Health Behav* 2008;**32(2)**:137-45.  
51

52  
53 <sup>6</sup> Pollak KI, Denman S, Gordon KC, et al. Is pregnancy a teachable moment for smoking  
54 cessation among US Latino expectant fathers? A pilot study. *Ethn Health* 2010;**15(1)**:47-59.  
55  
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- <sup>7</sup> Shi Y, Warner DO. Surgery as a teachable moment for smoking cessation. *Anesthesiology* 2010;**112(1)**:102-7doi:10.1097/ALN.0b013e3181c61cf9.
- <sup>8</sup> Phelan S. Pregnancy: a “teachable moment” for weight control and obesity prevention. *Am J of Obstet Gynecol* 2010;**202(2)**:135.e1-8doi:10.1016/j.ajog.2009.06.008.
- <sup>9</sup> Shi L, Iguchi MY. ‘Risk homeostasis’ or ‘teachable moment’? the interaction between smoking behavior and lung cancer screening in the Mayo Lung Project. *Tob Indu Dis* 2011;**9(1)**:2doi:10.1186/1617-9625-9-2.
- <sup>10</sup> Dohnke B, Ziemann C, Will KE, et al. Do hospital treatments represent a ‘teachable moment’ for quitting smoking? A study from a stage-theoretical perspective. *Psychol and Health* 2012;**27(11)**:1291-307doi:10.1080/08870446.2012.672649.
- <sup>11</sup> Lawson PJ, Flocke SA. Teachable moments for health behavior change: A concept analysis. *Patient Educ and Couns* 2009;**76(1)**:25-30doi:10.1016/j.pec.2008.11.002.
- <sup>12</sup> Robb KA, Power E, Kralj-Hans I, et al. The impact of individually-tailored lifestyle advice in the colorectal cancer screening context: a randomised pilot study in North-West London. *Prev Med* 2010 Dec;**51(6)**:505-8. doi: 10.1016/j.ypmed.2010.10.002. Epub 2010 Oct 13.
- <sup>13</sup> Williams K, Steptoe A, Wardle J. Is a cancer diagnosis a trigger for health behaviour change? Findings from a prospective, population-based study. *British J Cancer* 2013;**108**: 2407–2412. doi: 10.1038/bjc.2013.254
- <sup>14</sup> Lemon SC, Zapka JG, Clemow L. Health behavior change among women with recent familial diagnosis of breast cancer. *Prev Med*. 2004 Aug;**39(2)**:253-62.
- <sup>15</sup> NHS Atlas of Variation in Healthcare 2011. CANCERS AND TUMOURS. Map 1: Rate of colonoscopy procedures and flexisigmoidoscopy procedures per population by PCT. [http://www.rightcare.nhs.uk/atlas/downloads/CancerMaps\\_AoV\\_2011.pdf](http://www.rightcare.nhs.uk/atlas/downloads/CancerMaps_AoV_2011.pdf) Accessed 4/6/13.
- <sup>16</sup> DH Knowledge & Intelligence Team, *Further Analysis of HES Endoscopy Data*, 2010.

1  
2  
3  
4 <sup>17</sup><http://www.dh.gov.uk/en/Publicationsandstatistics/Statistics/Perfomancedataandstatistics/index.htm>> Accessed 24.09.12.

5  
6  
7  
8 <sup>18</sup> McBride CM, Puleo E, Pollak KI, et al. Understanding the role of cancer worry in creating a  
9  
10 'teachable moment' for multiple risk factor reduction. *Soc Sci Med* 2008; **66(3)**:790-800.

11  
12  
13 <sup>19</sup> Glanz K, Lewis FM, Rimer BK. "Health Behavior and Health Education" (2002) ISBN 0-7879-  
14  
15 5715-1

16  
17 <sup>20</sup> Bandura A. Self-efficacy: The exercise of control. 1997; New York: WH Freeman and  
18  
19 Company.

20  
21 <sup>21</sup> Rogers RW. A protection motivation theory of fear appeals and attitude change. *Journal of*  
22  
23 *Psychology*. 1975;91:93-114.

24  
25 <sup>22</sup> <http://www.ipaq.ki.se/downloads.htm> Accessed 11/01/2013.

26  
27  
28 <sup>23</sup> Craig C L, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-  
29  
30 country reliability and validity. *Med Sci Sports Exerc* 2003; **35(8)**: 1381-95.

31  
32 <sup>24</sup> <http://www.foodfrequency.org.uk> Accessed 11/01/2013.

33  
34 <sup>25</sup> Masson LF, McNeill G, Tomany JO, et al. Statistical approaches for assessing the relative  
35  
36 validity of a food frequency questionnaire: use of correlation coefficients and the kappa  
37  
38 statistic. *Public Health Nutr* 2003; **6(3)**:313-21.

39  
40 <sup>26</sup> <http://www.who.int/dietphysicalactivity/en/> Accessed 11/01/2013.

41  
42  
43 <sup>27</sup> World Cancer Research Fund / American Institute for Cancer Research.  
44  
45 Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective.  
46  
47 Washington DC: AICR, 2007.

48  
49 <sup>28</sup> Scottish Government, Healthy Eating, Active Living: An action plan to improve diet,  
50  
51 increase physical activity and tackle obesity (2008-2011), 2008, Scottish Government,  
52  
53 Edinburgh.

54  
55 <http://www.scotland.gov.uk/Resource/Doc/228860/0061963.pdf> Accessed 27/09/2013.

56  
57  
58 <sup>29</sup> Scottish Government, *Changing Scotland's Relationship with Alcohol: A Framework for*  
59  
60



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Action, 2009. Scottish Government, Edinburgh.

<http://www.scotland.gov.uk/Resource/Doc/262905/0078610.pdf> Accessed 27/09/2013.

<sup>30</sup> <http://simd.scotland.gov.uk/publication-2012/> Accessed 11/01/2013.

<sup>31</sup> Wallston KA. The validity of the multidimensional health locus of control scales. *J Health Psychol* 2005;**10(5)**:623-31.

<sup>32</sup> Wallston KA, Wallston BS, DeVellis R. Development of the Multidimensional Health Locus of control (MHLC) Scales. *Health Educ Monogr* 1978; **6(2)**:160-70.

<sup>33</sup> [http://userpage.fu-berlin.de/%7Ehealth/faq\\_gse.pdf](http://userpage.fu-berlin.de/%7Ehealth/faq_gse.pdf) Accessed 11/01/2013.

<sup>34</sup> Schwarzer, R, **Everything you wanted to know about the General Self-Efficacy Scale but were afraid to ask, 2011,**

[http://userpage.fu-berlin.de/%7Ehealth/faq\\_gse.pdf](http://userpage.fu-berlin.de/%7Ehealth/faq_gse.pdf) Accessed 27/01/2013.

<sup>35</sup> Satia JA, Campbell MK, Galanko JA, et al. Longitudinal changes in lifestyle behaviours and health status in colon cancer survivors. *Cancer Epidemiol Biomarker Prev* 2004;**13(6)**:1022-31.

<sup>36</sup> van der Aalst CM, van Klaveren RJ, de Koning HJ. Does participation to screening unintentionally influence lifestyle behavior and thus lifestyle-related morbidity? *Best Pract Res Clin Gastroenterol* 2010;**24(4)**:465-78doi:10.1016/j.bpg.2010.06.001.

<sup>37</sup> Newson JT, Huguet N, Ramage-Morin PL, et al. Health behaviour changes after diagnosis of chronic illness among Canadians aged 50 or older. Statistics Canada, Catalogue no. 82-003-XPE • Health Reports, Vol. 23, no. 4, December 2012

<sup>38</sup> Scottish Government, *The Scottish Health Survey: Summary of Key Findings*, Scottish Government, Edinburgh, 2012.

<sup>39</sup> Hepper NG, Drage CW, Davies SF, et al. Chronic obstructive pulmonary disease: a community-oriented program including professional education and screening by a voluntary health agency. *Am Rev Respir Dis* 1980; **121(1)**:97-104.

<sup>40</sup> Ostroff JS, Buckshee N, Mancuso CA, et al. Smoking cessation following CT screening for early detection of lung cancer. *Prev Med* 2001; **33(6)**:613-21.

<sup>41</sup> Brener ND, Billy JO, Grady WR. Assessment of Factors Affecting the Validity of Self-Reported Health-Risk Behavior Among Adolescents: Evidence From the Scientific Literature. *J Adolesc Health* 2003;**33(6)**:436–57.

<sup>42</sup> <http://www.healthscotland.com/topics/settings/health/index.aspx#hphs> Accessed 19/01/2013.

<sup>43</sup> Backer V, Nelbom BM, Duus BR, et al. Introduction of new guidelines for emergency patients: motivational counseling among smokers. *Clin Respir J* 2007;**1(1)**:37-41doi: 10.1111/j.1752-699X.2007.00006.x.

<sup>44</sup> Bernstein SL, Boudreaux ED, Cydulka RK, et al. Tobacco control interventions in the emergency department: A joint statement of emergency medicine organizations. *Ann Emerg Med* 2006;**48(4)**:e417-26.

<sup>45</sup> Anderson A; Promoting changes in diet and physical activity in breast and colorectal cancer screening settings: *Cancer Prevention research* 2013;**6(3)**:165-72.

<sup>46</sup> Stead M, Eadie D, Caswell S, et al. Understanding the potential and challenges of adenoma treatment as a prevention opportunity: insights from the BeWEL formative study *Prev Med* 2012;**54(1)**:97-103.

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**Registrations**

REC REF 10/S0709/24

UKCRN 9911

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**Competing interests:** All authors had no support from any organisation for the submitted work, no financial relationships with any organisations that might have an interest in the submitted work in the previous three years and no other relationships or activities that could appear to have influenced the submitted work.

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**Study hypothesis:** The study hypothesis that major health events are teachable moments triggering spontaneous health-related behaviour change arose before inspection of the data.

The main hypothesis was that colorectal cancer diagnosis is a teachable moment. This article reports a further study hypothesis, which was that colonoscopy is a teachable moment.

**Data sharing statement:** The relevant anonymised patient level data are available on reasonable request from the corresponding author. Participant consent was not obtained but the presented data are anonymised and risk of identification is low.

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Table Error! Main Document Only.. Patient and partner baseline characteristics.

	Patients (n=536)				Partners of patients (n=438)		
	All (n=536)	ARN (n=387)	NRN (n=149)	p <sup>1</sup>	ARN (n=318)	NRN (n=120)	p <sup>2</sup>
<b>Sex:</b> Male	308 (57)	236 (61)	72 (48)	<b>0.008</b>	121 (38)	56 (47)	0.101
Female	228 (43)	151 (39)	77 (52)		197 (62)	64 (53)	
<b>Age (years):</b> mean ± SE	60.8 ± 0.5	62.1 ± 0.6	57.6 ± 1.1	<b>&lt;0.001</b>	62.0 ± 0.6	56.8 ± 1.2	<b>&lt;0.001</b>
<b>SIMD quintile:</b>							
1 (most deprived)	41 (8)	31 (8)	10 (7)	0.979	26 (9)	9 (8)	0.425
2	76 (14)	56 (15)	20 (14)		40 (13)	9 (8)	
3	91 (17)	65 (17)	26 (18)		48 (16)	25 (22)	
4	131 (25)	93 (25)	38 (26)		78 (26)	28 (24)	
5 (least deprived)	186 (35)	134 (35)	52 (36)		113 (37)	44 (38)	
<b>Highest level of education:</b> School completed	282 (53)	208 (54)	74 (50)	0.578	171 (54)	51 (43)	0.092
College/University	197 (37)	137 (35)	60 (40)		120 (38)	55 (46)	
Postgrad degree completed	57 (11)	42 (11)	15 (10)		26 (8)	14 (12)	
<b>Employment status:</b>							
Self-employed/paid emp.	231 (43)	153 (40)	78 (52)	<b>0.010</b>	128 (41)	71 (59)	<b>0.001</b>
Not employed	14 (3)	11 (3)	3 (2)		3 (1)	5 (4)	
Retired from paid work	252 (47)	196 (51)	56 (38)		154 (49)	38 (32)	
Looking after family-home	22 (4)	12 (3)	10 (7)		24 (8)	4 (3)	
Long term sick or disabled	15 (3)	13 (3)	2 (1)		7 (2)	2 (2)	
<b>Household income:</b>							
Under £20,000	138 (30)	108 (32)	30 (25)	<b>0.040</b>	85 (31)	29 (28)	<b>0.002</b>
£20,000-29,999	99 (21)	79 (23)	20 (17)		71 (26)	12 (12)	
£30,000-39,00	60 (13)	46 (13)	14 (12)		43 (16)	13 (13)	
£40,000-49,000	61 (13)	42 (12)	19 (16)		25 (9)	13 (13)	
£50,000 and above	104 (23)	66 (19)	38 (31)		53 (19)	37 (36)	
<b>Physical activity</b> (MET-minutes/week)		4152 [1997, 7668]	4381 [2157, 7338]	0.801	4250 [1980, 8406]	4134 [1964, 8178]	0.917
<b>Risk behaviour</b>							
1. <5 measures/day of fruit & vegetables	93 (27)	70 (28)	23 (25)	0.493	62 (29)	20 (27)	0.764
2. <3 measures/day of bread & consume white bread only	75 (15)	54 (15)	21 (15)	0.989	49 (16)	12 (10)	0.126
3. >4 (men) & >3 (women) units/day of alcohol	88 (20)	67 (22)	21 (17)	0.267	36 (14)	26 (28)	0.002
4. Current smoker	54 (11)	36 (10)	18 (13)	0.320	36 (12)	19 (17)	0.169

5. Low physical activity level	203 (50)	159 (54)	44 (40)	0.009	135 (53)	40 (41)	0.050
6. Obese (BMI $\geq$ 30.0 kg/m <sup>2</sup> )	92 (21)	70 (23)	22 (18)	0.355	44 (19)	25 (26)	0.205
<b>Risk behaviour score group</b>							
1 or less	154 (48)	102 (45)	52 (58)	0.026	88 (45)	31 (44)	0.930
2 or more	164 (52)	127 (55)	37 (42)		108 (55)	39 (56)	

<sup>1</sup>P-value for difference between patients; <sup>2</sup>P-value for difference between partners

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**Table Error! Main Document Only.: Self-efficacy and multidimensional health locus of control scores at baseline (ARN and NRN patients and their partners): median [IQR]**

	Patients			Partners of patients		
	ARN (n=387)	NRN (n=149)	p <sup>1</sup>	ARN (n=318)	NRN (n=120)	p <sup>2</sup>
<b>Smoking cessation self-efficacy<sup>3</sup></b>						
Score (range 5 - 20)	12 [9, 16]	13 [9, 18]	0.355	11 [9, 14]	10 [7, 12]	0.055
Low (5 - 12): n (%)	20 (51)	8 (42)	0.512	20 (54)	14 (82)	<b>0.045</b>
High (13 - 20): n (%)	19 (49)	11 (58)		17 (46)	3 (18)	
<b>Physical activity self-efficacy</b>						
Score (range 5 - 20)	14 [11, 15]	14 [12, 18]	0.073	14 [11, 17]	14 [10, 16]	0.948
Low (5 - 14): n (%)	205 (55)	76 (52)	0.530	163 (53)	65 (56)	0.588
High (15 - 20): n (%)	167 (45)	70 (48)		144 (47)	51 (44)	
<b>Diet self-efficacy</b>						
Score (range 5 - 20)	15 [14, 18]	15 [14, 20]	0.121	15 [14, 19]	15 [12, 20]	0.875
Low (5 - 15): n (%)	230 (62)	84 (59)	0.566	191 (62)	73 (64)	0.731
High (16 - 20): n (%)	144 (39)	59 (41)		116 (38)	41 (36)	
<b>Alcohol resistance self-efficacy</b>						
Score (range 3 - 12)	9 [7, 12]	10 [7, 12]	0.657	11 [8, 12]	10 [7, 12]	0.530
Low (3 - 10): n (%)	187 (55)	71 (55)	0.956	133 (48)	55 (51)	0.511
High (11 - 12): n (%)	151 (45)	58 (45)		146 (52)	52 (49)	
<b>MHLC Internal</b>						
Score (range 6 - 36)	25 [22, 28]	26 [21, 29]	0.381	26 [22, 28]	26 [22, 29]	0.696
Low (6 - 25): n (%)	203 (53)	72 (49)	0.415	152 (48)	59 (50)	0.783
High (26 - 36): n (%)	183 (47)	76 (51)		164 (52)	60 (50)	
<b>MHLC Chance</b>						
Score (range 6 - 36)	17 [13, 21]	17 [13, 21]	0.335	18 [14, 22]	17 [13, 22]	0.788
Low (6 - 17): n (%)	197 (51)	83 (56)	0.332	154 (49)	61 (51)	0.638
High (18 - 36): n (%)	189 (49)	66 (44)		162 (51)	58 (49)	
<b>MHLC Powerful others</b>						
Score (range 6 - 36)	18 [14, 23]	17 [12, 21]	<b>0.032</b>	18 [13, 22]	15 [11, 20]	<b>0.018</b>
Low (6 - 17): n (%)	186 (48)	77 (52)	0.442	154 (49)	75 (63)	<b>0.008</b>
High (18 - 36): n (%)	199 (52)	71 (48)		162 (51)	44 (37)	

<sup>1</sup>P-value for difference between patients

<sup>2</sup>P-value for difference between partners

<sup>3</sup>Current smokers only

**Table Error! Main Document Only.: Change in patient risk behaviours between T1 and T2: n (%)**

	All patients (n=418)*			ARN (n=387)			NRN (n=149)		
	T1	T2	p <sup>1</sup>	T1	T2	p <sup>1</sup>	T1	T2	p <sup>2</sup>
<b>Risk behaviour</b>									
<5 measures/day of fruit & vegetables	38 (23)	40 (24)	0.845	28 (24)	30 (26)	0.815	9 (20)	7 (15)	0.687
<3 measures/day of bread & consume white bread only	46 (12)	43 (11)	0.766	34 (13)	30 (11)	0.585	11 (11)	10 (10)	1.000
>4 (men) & >3 (women) units/day of alcohol	58 (21)	45 (16)	<b>0.047</b>	41 (22)	31 (17)	0.064	14 (17)	13 (16)	1.000
Current smoker	27 (8)	24 (7)	0.250	15 (6)	13 (5)	0.500	10 (10)	9 (9)	1.000
Low physical activity level	131 (50)	150 (58)	<b>0.003</b>	98 (54)	112 (61)	<b>0.01</b>	25 (40)	29 (46)	0.055
Moderate physical activity	37(14)	41(16)		61(33)	28 (15)		9 (14)	11 (17)	
High physical activity	92 (35)	69 (27)			43 (24)		29 (46)	23 (37)	
Obese (BMI≥30.0 kg/m <sup>2</sup> )	56 (19)	64 (22)	0.152	43 (21)	49 (24)	0.238	10 (14)	11 (15)	1.000
<b>Risk behaviour score group (number of risk behaviours)</b>									
1 or less	84 (54)	80 (51)	0.572	52 (49)	47 (44)	0.359	29 (67)	30 (70)	1.000
2 or more	73 (47)	77 (49)		55 (51)	60 (56)		14 (33)	13 (30)	

<sup>1</sup>P-value for difference between T1 and T2 in patients with an abnormal diagnosis

<sup>2</sup>P-value for difference between T1 and T2 in patients with a normal diagnosis

\* Includes patients with missing diagnosis.



**Table Error! Main Document Only.: Predictors of low physical activity at T2 in patients (n=268)**

	Odds Ratio	95% CI	P
Low PA at T1 (versus high)	26.2	(9.57, 71.7)	<b>&lt;0.001</b>
Age (years)	1.07	(1.02, 1.12)	<b>0.005</b>
Female sex (versus male)	0.73	(0.29, 1.81)	0.495
SIMD Quintile			
1	1.00		
2	0.98	(0.14, 6.67)	0.981
3	1.65	(0.23, 11.8)	0.618
4	4.93	(0.77, 31.6)	0.093
5	1.70	(0.29, 10.1)	0.558
Any medical conditions (versus none)	1.13	(0.44, 2.93)	0.801
ARN (versus NRN)	1.17	(0.44, 3.13)	0.749
Raw MHLC Internal score	0.96	(0.88, 1.05)	0.421
Raw MHLC Chance score	0.99	(0.91, 1.07)	0.775
Raw MHLC Powerful others score	1.06	(0.98, 1.15)	0.126
Raw Physical activity self-efficacy score	0.99	(0.96, 1.02)	0.517
Raw Time spent sitting per day (including motor vehicle)	1.00	(0.99, 1.00)	0.922
Constant	0.004	(0.00, 0.26)	0.009

**Table Error! Main Document Only.: Predictors of high alcohol intake at T2 in patients (n=232)**

	<b>Odds Ratio</b>	<b>95% CI</b>	<b>P</b>
>4(men) & >3 (women) units/day alcohol at T1	12.4	(4.83, 31.5)	<b>&lt;0.001</b>
Age (years)	0.99	(0.95, 1.03)	0.601
Female sex (versus male)	1.02	(0.39, 2.63)	0.975
SIMD Quintile			
1	1.00		
2	4.87	(0.48, 49.5)	0.181
3	3.23	(0.33, 31.5)	0.313
4	1.23	(0.15, 10.1)	0.847
5	1.96	(0.24, 15.8)	0.525
Any medical conditions (versus none)	0.66	(0.23, 1.89)	0.441
Abnormal diagnosis (versus normal)	0.83	(0.29, 2.34)	0.725
Raw MHLC Internal score	1.00	(0.92, 1.08)	0.988
Raw MHLC Chance score	0.97	(0.88, 1.07)	0.556
Raw MHLC Powerful others score	1.00	(0.93, 1.08)	0.905
Raw Alcohol self-efficacy score	0.70	(0.58, 0.84)	<b>&lt;0.001</b>
Constant	3.74	(0.04, 360.3)	0.572

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7 **Do health behaviours change after colonoscopy? A prospective cohort study on diet,**  
8 **alcohol, physical activity and smoking among patients and their partners.**  
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11  
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28 **Words:** colorectal neoplasms, colonoscopy, behavior, diet  
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## ABSTRACT

### Objectives

We hypothesised that colonoscopy triggers changes for the better in health behaviours. Our objective was to describe diet, alcohol, physical activity and tobacco use prospectively i.e. before and 10 months after colonoscopy for patients and their partners.

### Design

Prospective cohort study of health behaviour change in patients and their partners before and 10 months after colonoscopy. Comparison groups are patients receiving a normal result notification (NRN) versus patients receiving an abnormal result notification (ARN) such as, colorectal cancer, polyps or diverticulitis. Health behaviour change of patients and partners (controls) are also compared.

### Setting

5 Scottish hospitals.

### Participants

Of 5,798 colonoscopy registrations, 2,577 (44%) patients met eligibility criteria of whom 565 (22%) were recruited; 460 partners were also recruited.

### Measures

International Physical Activity Questionnaire, Scottish Collaborative Group Food Frequency Questionnaire (includes alcohol), smoking status, age, sex, education, household income, employment status, Scottish Index of Multiple Deprivation (SIMD), Body Mass Index,

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3 medical conditions, result of the colonoscopy (~~abnormal result notification~~ (ARN) or ~~normal~~  
4 ~~result notification~~ (NRN)), Multidimensional Health Locus of Control Scale (MHLC),  
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7 behaviour-specific self-efficacy scales.  
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## 11 Results

12  
13 57% of patients were male, mean age 60.8 years (SE 0.5) and 43% were from more affluent  
14 areas. 72% (n=387) of patients received an ARN and 28% (n=149) a NRN. Response rate to  
15  
16 the second questionnaire at 10 months was 68.9%. Overall, 27% of patients consumed less  
17  
18 than 5 measures of fruit & vegetables per day, 20% exceeded alcohol limits, 50% had low  
19  
20 levels of physical activity and 21% were obese. At 10 month follow-up, a 5% reduction in  
21  
22 excessive alcohol consumption and an 8% increase in low levels of physical activity were  
23  
24 observed among patients; no significant behavioural changes occurred in their partners.  
25  
26 Baseline high alcohol consumption and low physical activity were the strongest predictors of  
27  
28 these behaviours at follow-up. Additionally, low alcohol self-efficacy and increasing age  
29  
30 were associated with poorer health-related behaviours at follow-up for alcohol and physical  
31  
32 activity, respectively.  
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## 40 Conclusions

41  
42 Colonoscopy can be regarded as a teachable moment for patients, being associated with  
43  
44 marginal beneficial changes in some health behaviours. Yet, colonoscopy is also associated  
45  
46 with negative changes in health behaviours. Further work is needed to explore how services  
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48 can optimize increases in beneficial health behaviours and mitigate increases in harmful  
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50 ones.  
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For peer review only

## Article summary

### Article focus

- Colonoscopy is an increasingly common investigation that might trigger spontaneous behavioural changes in patients.
- Little is known about health behaviour change following colonoscopy, particularly in the UK.
- We carried out a prospective cohort study of patients who underwent colonoscopy and their partners.

### Key messages

- There is a high prevalence of unhealthy behaviours in colonoscopy patients.
- We observed marginal but statistically significant reductions in excessive alcohol consumption but also decreases in physical activity following colonoscopy.
- There may be opportunities to encourage spontaneous improvements in health behaviours among colonoscopy patients and to mitigate harmful behaviours.

### Strengths and limitations of this study

- This is the first prospective cohort ~~observational~~ study on health behaviours in colonoscopy patients in the UK.



- We obtained a large sample size and high follow-up rate and were able to use patients' partners as controls.
- Selection biases may have led to our sample comprising healthier patients than in the general colonoscopy population.

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## INTRODUCTION

Illnesses and interactions with health services may motivate patients to change their [health behaviours for the better](#). Such “teachable moments” have been described for changes in smoking behaviour following life transitions, such as pregnancy, and health events, such as screening for lung cancer.<sup>1,2,3,4,5,6,7,8,9,10</sup> A recent review of the literature concludes that while the term “teachable moment” is used imprecisely – to describe either an opportunity for behavioural change or an event associated with actual change - there is evidence that beneficial behavioural changes can be actively created through appropriate clinician-patient interactions.<sup>11</sup> To our knowledge, evidence from the UK that patients who undergo screening for cancer are likely to make improvements in health behaviour is limited to a single pilot study of a health promotion intervention delivered during colorectal cancer screening.<sup>12</sup> The evidence from [UK](#) observational research that there are spontaneous health behaviour changes after a cancer diagnosis is limited to [retrospective](#) analyses of population surveys that depend on self-reported cancer diagnosis [and found little evidence that a cancer diagnosis motivates health-protective changes](#).<sup>13</sup> Relatives of cancer patients may also change their behaviour in response to a familial diagnosis, but the evidence is limited to one study on breast cancer.<sup>14</sup>

Colonoscopy is mainly performed for the diagnosis of colon and rectal cancer and current UK rates of 80 procedures per 10,000 population are likely to increase in the future as screening by flexible sigmoidoscopy is introduced.<sup>15</sup> The number of colonoscopies performed through the Scottish bowel screening programme almost doubled from 5,358 in 2009 to 9,296 in 2011; in England, 368,162 colonoscopies were carried out in 2009-10.<sup>16,17</sup> We hypothesised that colonoscopy represents both concepts of a teachable moment for [beneficial](#) health

behaviour change: it may be a time of concern about a cancer diagnosis and thus be associated with spontaneous change,<sup>14,18</sup> and it may also present an opportunity for clinicians to promote improvements in behaviours. An abnormal colonoscopy result may be more likely to trigger beneficial changes in behaviour, so we compared behaviours between participants with normal and abnormal test results. Our aim was to describe health-related behaviours before and after a colonoscopy among patients and their partners. Our objective was to carry out a prospective observational study on colonoscopy patients and their partners using self-reported questionnaire survey data immediately before and ten months after colonoscopy. As self-efficacy and locus of control are central to several health behaviour theories, including the Health Belief Model,<sup>19</sup> Social Cognitive Theory<sup>20</sup> and Protection Motivation Theory,<sup>21</sup> we assessed their roles using validated questionnaires and also recorded physical activity, tobacco smoking, diet and alcohol consumption. We hypothesised that study participants with high scores of self-efficacy and with 'internal' locus of control would change health behaviours for the better following colonoscopy. Although there is no cut-off score to define persons as being high or low self-efficacious Ralph Schwarzer, an expert in self-efficacy measurement, recommends conducting a median split, which is to dichotomize the study sample.<sup>35</sup> 'Health-Internals' believe that the locus of control for health is internal and that one stays or becomes healthy or sick as a result of his or her behaviour whereas 'health-externals' believe that factors which determine their health are such things as 'powerful others' and 'chance' over which they have little control.

## METHODS

### Study design

We conducted a prospective cohort study of health behaviour change in patients and their partners before and 10 months after colonoscopy. Comparison groups are patients

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3 receiving a normal result notification (NRN) versus patients receiving an abnormal result  
4 notification (ARN) such as, colorectal cancer, polyps or diverticulitis. Health behaviour  
5 change of patients and partners (controls) are also compared.  
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8  
9 ~~Prospective cohort study of health behaviours of patients referred for colonoscopy and their~~  
10 ~~partners.~~  
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### 13 14 15 16 **Setting**

17 Colonoscopy clinics in five hospitals within three Health Board areas in Scotland, UK.

18 Recruitment occurred between September 2010 and August 2011.

### 21 22 23 24 25 **Participants**

26 Patients were invited by an advert for the study enclosed along with their colonoscopy  
27 appointment letter from the hospital. On attendance for colonoscopy, clinic staff obtained  
28 verbal consent for patients (and, if present, their partners) to allow the Research Assistant  
29 (RA) to approach them. If a patient did not wish to be approached by the RA, consent was  
30 sought to retain non-identifiable data (age, sex and sector level of the postcode) to assess  
31 selection bias. The RA asked consenting participants to complete the baseline (T1)  
32 questionnaire and written consent form at home and return both in a pre-paid addressed  
33 envelope. Patients whose partners were not present were asked to provide the name and  
34 contact details of their partner who was subsequently contacted by the RA by telephone  
35 about the study.  
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### 50 51 **Eligibility criteria**

52 Patient inclusion criteria were: i) referred for colonoscopy, ii) no past history of cancer, iii)  
53 ≥18 years old, iv) has a partner. Partner inclusion criteria: i) ≥18 years old, ii) no history of  
54 cancer.  
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### Primary outcome

The primary outcome measure was the extent of change in individual health behaviours before colonoscopy and 10 months later. Consequently, we selected measures that ranked individuals along a distribution of amount of physical activity, dietary and alcohol intake, and tobacco use.

### **Variables, measures and data sources**

Information was self-reported by participants or obtained from medical records.

#### Health-related behaviour variables

The International Physical Activity Questionnaire<sup>22,23</sup> was used to categorise participants into low, moderate or high levels of PA using Metabolic Equivalent of Task (MET) scores. The Scottish Collaborative Group Food Frequency Questionnaire (SCG FFQ)<sup>24,25</sup> was used to measure intakes of foods and alcohol. Current smokers were defined as those who had smoked at least 100 cigarettes in their entire life and currently smoked.

An aggregate risk behaviour score was calculated based on generally accepted requirements for risk factor reduction for most of the main chronic diseases and specifically for prevention of colorectal cancer because colonoscopy is a main investigation for colorectal cancer symptoms.<sup>26,27</sup> Specifically, we defined high risk behaviour using Scottish government recommendations<sup>28,29,30</sup> as follows: <5 measures/day of fruit and vegetables; <3 portions/day of bread; >4 (men) and >3 (women) units/day of alcohol; current smoker; and low physical activity (equivalent to less than thirty minutes of moderate intensity activity on at least 4 days of the week). For the purpose of this study, a 'measure' as defined in the SCG FFQ was assumed to be equal to a 'portion' of fruit or vegetables.

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3 Demographic variables

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5 Participants self-reported their age, sex, level of education, household income, employment  
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7 status, and postcode (to calculate Scottish Index Multiple Deprivation (SIMD<sup>31</sup>)).  
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12 Clinical variables

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14 Body Mass Index (BMI) was calculated by dividing weight (kg) by height squared (m<sup>2</sup>) using  
15  
16 self-reported values. Participants were categorised as obese if BMI $\geq$ 30.0 kg/m<sup>2</sup>. Participants  
17  
18 self-reported their medical conditions currently being treated by a doctor. Result of the  
19  
20 colonoscopy was obtained from patient medical records. Patients were categorised as  
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22 receiving a normal result notification (NRN) or abnormal result notification (ARN) such as,  
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24 colorectal cancer, polyps or diverticulitis.  
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29 Psychological variables

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31 Participants' perceived control over their health-related behaviours was measured using the  
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33 Multidimensional Health Locus of Control Scale<sup>32,33</sup>. The instrument measures three  
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35 dimensions of control: internal, powerful others and chance. Participants' self-efficacy was  
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37 measured using four separate self-efficacy scales (smoking, diet, alcohol, PA) recommended  
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39 by Schwarzer and colleagues.<sup>34</sup> There is no cut-off score to define persons as being high or  
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41 low self-efficacious so we split the sample at the median, as recommended by Schwarzer.<sup>35</sup>  
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47 Data collection

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49 The baseline (T1) questionnaire was administered to patients who attended a colonoscopy  
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51 clinic between September 2010 and August 2011. A pre-paid envelope was provided for  
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53 participants to return the questionnaire after completing it at home. Participants were  
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55 requested to report health behaviours before colonoscopy. There was no cut-off date for  
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3 returning the baseline questionnaire. The follow-up questionnaire (T2) was posted 10  
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5 months after the clinic date for colonoscopy, between July 2011 and June 2012.  
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### 8 9 **Bias**

10 We attempted to minimise information biases by using, where possible, validated  
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12 questionnaires and to minimise selection biases by inviting all colonoscopy patients to  
13  
14 participate.  
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### 17 18 19 20 **Sample size and ~~S~~statistical analysis**

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22 Statistical analysis was carried out using Stata/SE 11.2 software. Means  $\pm$  standard errors or  
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24 medians [interquartile range (IQR)] were presented as appropriate following visual  
25  
26 assessment of histograms of continuous variables. Differences in characteristics and  
27  
28 behaviours between groups were assessed using Pearson's chi-squared test for categorical  
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30 measures and either T-tests or Mann-Whitney tests for continuous variables as appropriate.  
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32 Differences in continuous variables between T1 and T2 were assessed using a paired T-test  
33  
34 or the Wilcoxon signed-rank test. Differences in categorical variables between T1 and T2  
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36 were assessed in SPSS version 20 using the McNemar-Bowker test for variables with 3 or  
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38 more categories, and the McNemar test for binary variables. To predict health-related  
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40 behaviour at T2 logistic regression models were undertaken.  
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### 46 **Statistical power**

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48 Our sample size was based on answering the research question 'Do health behaviours  
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50 change after a major health threat?' We used the variable physical activity to calculate  
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52 statistical power because it has the strongest association with colorectal cancer survival and  
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54 detecting colorectal cancer is one of the main reasons for colonoscopy referral. This paper  
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56 reports a comparison of changes in health behaviours of patients with NRN and ARN  
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3 following colonoscopy. However, the study had initially aimed to detect an increase in  
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5 physical activity of 25 or greater MET hours in patients diagnosed with cancer at  
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7 colonoscopy compared to non-cancer patients, and samples of 46 cancer and 46 non-cancer  
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9 patients would have been required. The effect size was derived from Satia,<sup>36</sup> and sample  
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11 size calculations assumed conventional values of  $\alpha=0.05$  and  $\beta=0.20$  (giving a power, or  $1-\beta$ ,  
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13 of 80%). Thus, our study numbers exceeded those required by the initial sample size  
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15 calculation.  
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## 20 RESULTS

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25 Of 5,798 colonoscopy registrations, 2,577 patients (44%) met eligibility criteria for the study  
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27 of whom 565 (22%) eligible patients and 460 partners were recruited (**Error! Reference**  
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29 **source not found.**Figure 1). Recruited patients compared to non-recruited patients were  
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31 significantly older ( $60.3 \pm 0.5$  versus  $57.2 \pm 0.4$ ), more affluent (Carstairs decile 1 and 2, 43%  
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33 versus 29%) and a higher proportion male (57% males versus 50% male). **72% (n=387) of**  
34  
35 **patients received an ARN and 28% (n=149) a NRN.** Overall, 68.9% (n=706) of participants  
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37 returned a second, follow-up questionnaire at T2. The median times for both patients and  
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39 partners to return the baseline questionnaire was 12 days.  
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48 At baseline (T1), a higher proportion of patients with abnormal result notification (ARN)  
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50 were male, older, retired, and with a household income under £20,000 compared to  
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52 patients with normal result notification (NRN) - **Error! Reference source not**  
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54 **found.**Table 1. Overall 27% consumed less than five measures a day of fruit/vegetable,  
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56 20% exceeded recommended alcohol limits, 50% had low levels of physical activity and 21%  
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3 were obese. Higher proportions of ARN patients were not meeting these recommendations  
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5 but the difference was only significant for physical activity. Only 11% of patients reported  
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7 current smoking. When combined, overall 52% of participants had 2 or more risk  
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9 behaviours, which comprised 55% of ARN and 42% of NARN.  
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18 There were no significant differences between patients with abnormal and normal results  
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20 with respect to self-efficacy for smoking cessation, physical activity, diet and alcohol (Table  
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22 2). Partners of patients with normal results were more likely to have low self-efficacy for  
23  
24 smoking cessation.  
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30 {Please insert Table 2 here}

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33  
34 Overall, there was a 5% reduction in respondents who exceeded alcohol consumption  
35  
36 guidance and an 8% increase in the proportion with low physical activity - **Error!**  
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38 **Reference source not found.** Table 3. The proportionate increase in low physical  
39  
40 activity was similar in patients with abnormal and normal colonoscopy results but  
41  
42 statistically significant only among those with abnormal findings (which might be explained  
43  
44 by the larger sample size in the abnormal category). When risk behaviours were  
45  
46 aggregated, there was no overall change in behaviours in any patient group. We found no  
47  
48 significant change in health behaviours of partners, irrespective of the colonoscopy result of  
49  
50 the patient (data not shown).  
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56 {Please insert Table 3}

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7 We used multiple logistic regression analyses to explore predictors of the two behaviours  
8  
9 that changed significantly over time: low physical activity and high alcohol intake - **Error!**  
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11 **Reference source not found.** Table 4. Low physical activity at baseline was the  
12  
13 strongest predictor of low physical activity at T2 among patients and increasing age was also  
14  
15 associated with lower physical activity. Sex, socio-economic circumstances, co-morbidities,  
16  
17 colonoscopy findings and self-efficacy did not predict changes in physical activity over time.  
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23 **{Please insert Table 4}**

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25 Excessive alcohol consumption at T2 was most strongly determined by excessive  
26  
27 consumption at baseline - **Error! Reference source not found.** Table 5. Lower self-  
28  
29 efficacy at T1 was associated with higher alcohol consumption at T2. Age, sex, socio-  
30  
31 economic circumstances, co-morbidities and colonoscopy findings were not associated with  
32  
33 higher alcohol intake at follow-up.  
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38 **{Please insert Table 5}**

## 39 40 41 42 DISCUSSION

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44 Colonoscopy was associated with marginal spontaneous changes (that is, without a  
45  
46 behavioural intervention) in some health-related behaviours. We found that there was a 5%  
47  
48 reduction in excessive alcohol consumption (a beneficial change) but an 8% increase in low  
49  
50 levels of physical activity (a change for the worse) 10 months after colonoscopy. There  
51  
52 were no significant changes in health behaviours among patients' partners, suggesting that  
53  
54 behavioural changes in colonoscopy patients were not necessarily part of wider trends that  
55  
56 might influence health behaviour ~~temporal trends~~. No behavioural advice was given to  
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3 patients as part of their investigations, and thus colonoscopy might be regarded as a  
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5 teachable moment in which spontaneous changes are triggered. However, colonoscopy also  
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7 represents an interaction with health services that might be optimized to encourage  
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9  
10 improvements in health-related behaviours. At baseline, we found that ARN patients and  
11 their partners scored significantly higher than the NRN patients and partners on the MHLC  
12 Powerful Others scale, indicating that ARN patients and partners believed more strongly that  
13 health professionals were responsible for their health and health outcomes. Thus, ARN  
14 patients in particular, may be receptive to health promotion advice from health  
15 professionals.  
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25 Our ~~This~~ conclusion that colonoscopy can be regarded as a teachable moment is similar to a  
26  
27 recent systematic review of eleven articles about the impact of cancer screening (nine of  
28  
29 which investigated the impact of lung screening on smoking cessation) which concluded that  
30  
31 cancer screening 'might' be a teachable moment for health behaviour change<sup>37</sup>. Research  
32 about change in health behaviours after diagnosis of chronic health conditions indicate at  
33 best, only modest changes.<sup>38</sup> Thus, based on current evidence it remains uncertain if, and  
34 the extent to which major health events represent teachable moments. Health behaviours  
35 are likely to be influenced by a complex mix of factors, so that in addition to any beneficial  
36 teachable moment effects, ongoing symptoms that prompted colonoscopy may also affect  
37 behaviour. These may explain reductions in high levels of physical activity and concomitant  
38 increases in low levels.  
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50 We found that baseline health behaviours for low physical activity and excessive alcohol  
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52 consumption were the strongest predictors of the same behaviours 10 months after  
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54 colonoscopy but, additionally, increasing age predicted lower physical activity and lower  
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56 self-efficacy around alcohol predicted excessive alcohol consumption at follow-up. Among  
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3 our patient sample, 11% smoked, which is much lower than the Scottish general adult  
4  
5 population prevalence of 23%.<sup>39</sup>  
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9 This study found that a low level of PA at the time of colonoscopy and older age were  
10  
11 predictive of a low level of PA 10 months post-colonoscopy. Further, high alcohol intake at  
12  
13 the time of colonoscopy and low alcohol self-efficacy were predictive of high alcohol intake  
14  
15 post-colonoscopy. Of note, fatalism (MHLC Chance score) was not predictive of any  
16  
17 differential health behavior change. ARN was not predictive of health behaviour change  
18  
19 following this health event, which is in contrast to studies of smokers under-going screening  
20  
21 for lung disease.<sup>40,41</sup> A cross-sectional study of over 10,000 smokers at 2-3 years post-  
22  
23 screening for COPD found that those with a first-time positive result were significantly more  
24  
25 likely to stop smoking than those with a negative result<sup>40,35</sup>. A cross-sectional study of 134  
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27 active smokers who underwent spiral CT screening found that 62% of those with a positive  
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29 result either stopped or decreased smoking, whereas only 46% with a negative result did  
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31 so.<sup>41,36</sup> Thus, the effect of test results following screening for disease on health-related  
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33 behaviour appears to vary according to type of screen (e.g., colonoscopy versus spiral CT),  
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35 reason for screening (e.g., colon disease versus lung disease) and health-related behaviour  
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37 (e.g., alcohol versus smoking).  
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45 Our study has strengths and limitations. This is the first prospective observational study to  
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47 report health-related behaviours of patients and their partners before and 10 months after  
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49 colonoscopy. We used validated questionnaire survey tools, obtained a relatively large  
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51 sample for a prospective cohort study and achieved high follow-up rates of 69%. There are  
52  
53 however, several study limitations. First, the sample may not be representative of all  
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55 patients population undergoing colonoscopy. The response rate of eligible patients was 22%,  
56  
57 and there was some selection bias towards a more affluent, older and male population.  
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3 Socio-economic affluence may explain why our sample had lower smoking prevalence than  
4 the general population. Patients who participate in the newly introduced national colorectal  
5 cancer screening programme also may be more likely to be motivated to change in their  
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9 behaviour. Second, while participants were requested to self-report health behaviours  
10 before the colonoscopy and as soon as possible thereafter, the baseline questionnaire was  
11 completed after the colonoscopy when participants may already have been influenced and  
12 starting to make some changes and there was no cut-off date for returning the baseline  
13 questionnaire. Thus, the observed changes for the better or worse in health behaviours may  
14 be an under-estimation of the extent of change. Third, although valid and reliable survey  
15 instruments were used, self-reported data are susceptible to expectation biases and other  
16 misclassification effects.<sup>42</sup> However, our principal interest was in behavioural change rather  
17 than absolute prevalences of behaviours, and thus over- or under-reporting of certain  
18 behaviours would not necessarily invalidate our findings on whether they changed after  
19 colonoscopy. The observed decreases in excessive alcohol consumption and in physical  
20 activity following colonoscopy may not be caused by the procedure but by other  
21 confounding factors that we have not identified. We are not aware of any health promotion  
22 activity associated with colonoscopy as it was delivered within the participating hospitals  
23 and our questionnaires were designed not to imply any favourable behaviours. The fact that  
24 there were no observed changes in partners and no differences between ARN and NRN  
25 patients suggests that the observed behavioural changes in patients was related to the  
26 colonoscopy.

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51 Health care settings are recognised as important loci for promoting health behaviour  
52 change<sup>43,44,45</sup> and health events have been conceptualised as a teachable moment,  
53 particularly in relation to smoking cessation.<sup>1,2,3,4,5,6,7,8,9,10</sup> Conceptualising  
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60 health events as teachable moments may be appealing to policymakers and clinicians

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3 because they represent an opportunity to introduce low-intensity interventions to change  
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5 modifiable risk health-related behaviours to prevent disease and a recent review has  
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7 identified 9 lifestyle interventions at the point of cancer screening to take advantage of this  
8  
9 health event as a teachable moment , including 2 studies of a multiple lifestyle intervention  
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11 offered to people who had undergone colonoscopy and had adenomas removed.<sup>46,47</sup>  
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16 For future research, developing and testing the effect of low intensity interventions (e.g.,  
17  
18 self-efficacy enhancement) to further reduce alcohol consumption may be appropriate  
19  
20 because patients appear to spontaneously reduce alcohol consumption following  
21  
22 colonoscopy, whereas more intense interventions may be required for health-related  
23  
24 behaviours that do not change (e.g., diet) or change for the worse (e.g., physical activity).  
25  
26 Qualitative to understand why patients spontaneously change some health behaviours but  
27  
28 not others following a major health event will add to understanding about the utility of  
29  
30 teachable moments for public health.  
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37 <sup>1</sup> McBride CM, Emmons KM, Lipkus IM. Understanding the potential of teachable moments:  
38  
39 the case of smoking cessation. *Health Educ Res* 2003;**18(2)**:156-70.

40  
41 <sup>2</sup> Gritz ER, Fingeret MC, Vidrine DJ, et al. Successes and failures of the teachable moment:  
42  
43 smoking cessation in cancer patients. *Cancer* 2006;**106(1)**:17-27.

44  
45 <sup>3</sup> Sharp L, Johansson H, Fagerström K, et al. Smoking cessation among patients with head  
46  
47 and neck cancer: cancer as a 'teachable moment. *Eur J of Cancer Care(Engl)* 2008; **17(2)**:114-  
48  
49 119doi:10.1111/j.1365-2354.2007.00815.x.

50  
51 <sup>4</sup> McBride CM, Ostroff JS. Teachable moments for promoting smoking cessation: the context  
52  
53 of cancer care and survivorship. *Cancer Control* 2003;**10(4)**:325-33.  
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- <sup>5</sup> Simmons VN, Vidrine JI, Brandon TH. Smoking cessation counseling as a teachable moment for skin cancer prevention: pilot studies. *Am J Health Behav* 2008;**32(2)**:137-45.
- <sup>6</sup> Pollak KI, Denman S, Gordon KC, et al. Is pregnancy a teachable moment for smoking cessation among US Latino expectant fathers? A pilot study. *Ethn Health* 2010;**15(1)**:47-59.
- <sup>7</sup> Shi Y, Warner DO. Surgery as a teachable moment for smoking cessation. *Anesthesiology* 2010;**112(1)**:102-7doi:10.1097/ALN.0b013e3181c61cf9.
- <sup>8</sup> Phelan S. Pregnancy: a “teachable moment” for weight control and obesity prevention. *Am J of Obstet Gynecol* 2010;**202(2)**:135.e1-8doi:10.1016/j.ajog.2009.06.008.
- <sup>9</sup> Shi L, Iguchi MY. ‘Risk homeostasis’ or ‘teachable moment’? the interaction between smoking behavior and lung cancer screening in the Mayo Lung Project. *Tob Indu Dis* 2011;**9(1)**:2doi:10.1186/1617-9625-9-2.
- <sup>10</sup> Dohnke B, Ziemann C, Will KE, et al. Do hospital treatments represent a ‘teachable moment’ for quitting smoking? A study from a stage-theoretical perspective. *Psychol and Health* 2012;**27(11)**:1291-307doi:10.1080/08870446.2012.672649.
- <sup>11</sup> Lawson PJ, Flocke SA. Teachable moments for health behavior change: A concept analysis. *Patient Educ and Couns* 2009;**76(1)**:25-30doi:10.1016/j.pec.2008.11.002.
- <sup>12</sup> Robb KA, Power E, Kralj-Hans I, Atkin WS, Wardle J. The impact of individually-tailored lifestyle advice in the colorectal cancer screening context: a randomised pilot study in North-West London. *Prev Med* 2010 Dec;**51(6)**:505-8. doi: 10.1016/j.ypmed.2010.10.002. Epub 2010 Oct 13.
- <sup>13</sup> Williams K, Steptoe A, Wardle J. Is a cancer diagnosis a trigger for health behaviour change? Findings from a prospective, population-based study. *British J Cancer* 2013;**108**:2407–2412. doi: 10.1038/bjc.2013.254
- <sup>14</sup> Lemon SC, Zapka JG, Clemow L. Health behavior change among women with recent familial diagnosis of breast cancer. *Prev Med*. 2004 Aug;**39(2)**:253-62.

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56  
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- <sup>15</sup> NHS Atlas of Variation in Healthcare 2011. CANCERS AND TUMOURS. Map 1: Rate of colonoscopy procedures and flexisigmoidoscopy procedures per population by PCT. [http://www.rightcare.nhs.uk/atlas/downloads/CancerMaps\\_AoV\\_2011.pdf](http://www.rightcare.nhs.uk/atlas/downloads/CancerMaps_AoV_2011.pdf) Accessed 4/6/13.
- <sup>16</sup> DH Knowledge & Intelligence Team, *Further Analysis of HES Endoscopy Data*, 2010.
- <sup>17</sup> <http://www.dh.gov.uk/en/Publicationsandstatistics/Statistics/Performedataandstatistics/index.htm> Accessed 24.09.12.
- <sup>18</sup> McBride CM, Puleo E, Pollak KI, et al. Understanding the role of cancer worry in creating a 'teachable moment' for multiple risk factor reduction. *Soc Sci Med* 2008; **66(3)**:790-800.
- <sup>19</sup> Glanz K, Lewis FM, Rimer BK. "Health Behavior and Health Education" (2002) [ISBN 0-7879-5715-1](https://doi.org/10.1002/9780471571511)
- <sup>20</sup> Bandura A. *Self-efficacy: The exercise of control*. 1997; New York: WH Freeman and Company.
- <sup>21</sup> Rogers RW. A protection motivation theory of fear appeals and attitude change. *Journal of Psychology*. 1975;91:93-114.
- <sup>22</sup> <http://www.ipaq.ki.se/downloads.htm> Accessed 11/01/2013.
- <sup>23</sup> Craig C L, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* 2003; **35(8)**: 1381-95.
- <sup>24</sup> <http://www.foodfrequency.org.uk> Accessed 11/01/2013.
- <sup>25</sup> Masson LF, McNeill G, Tomany JO, et al. Statistical approaches for assessing the relative validity of a food frequency questionnaire: use of correlation coefficients and the kappa statistic. *Public Health Nutr* 2003; **6(3)**:313-21.
- <sup>26</sup> <http://www.who.int/dietphysicalactivity/en/> Accessed 11/01/2013.
- <sup>27</sup> World Cancer Research Fund / American Institute for Cancer Research. *Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective*. Washington DC: AICR, 2007.



1  
2  
3  
4 <sup>28</sup> [Scottish Government, Healthy Eating, Active Living: An action plan to improve diet,](#)  
5 [increase physical activity and tackle obesity \(2008-2011\), 2008, Scottish Government,](#)  
6 [Edinburgh.](#)  
7  
8

9  
10 <http://www.scotland.gov.uk/Resource/Doc/228860/0061963.pdf> Accessed  
11 [27/09/2013.](#) <http://www.scotland.gov.uk/Topics/Health/health/19133/17756>. Accessed  
12 [18/11/2009.](#)  
13  
14  
15  
16  
17

18  
19 <sup>29</sup> [Scottish Government, \*Changing Scotland's Relationship with Alcohol: A Framework for\*](#)  
20 [Action, 2009. Scottish Government, Edinburgh.](#)  
21  
22

23  
24 <http://www.scotland.gov.uk/Resource/Doc/262905/0078610.pdf>  
25 <http://www.scotland.gov.uk/Topics/Health/health/Alcohol/measures>. Accessed  
26 [27/09/2013.](#)  
27  
28  
29

30 <sup>30</sup> <http://www.scotland.gov.uk/Topics/Health/health/Introduction>. Accessed [18/11/2009.](#)  
31  
32

33 <sup>31</sup> <http://simd.scotland.gov.uk/publication-2012/> Accessed 11/01/2013.  
34

35 <sup>32</sup> Wallston KA. The validity of the multidimensional health locus of control scales. *J Health*  
36 *Psychol* 2005; **10(5)**:623-31.  
37  
38

39 <sup>33</sup> Wallston KA, Wallston BS, DeVellis R. Development of the Multidimensional Health Locus  
40 of control (MHLC) Scales. *Health Educ Monogr* 1978; **6(2)**:160-70.  
41  
42

43 <sup>34</sup> [http://userpage.fu-berlin.de/%7Ehealth/faq\\_gse.pdf](http://userpage.fu-berlin.de/%7Ehealth/faq_gse.pdf) Accessed 11/01/2013.  
44  
45

46 <sup>35</sup> [Schwarzer, R, \*Everything you wanted to know about the General Self-Efficacy Scale but\*](#)  
47 [were afraid to ask, 2011,](#)  
48  
49

50 [http://userpage.fu-berlin.de/%7Ehealth/faq\\_gse.pdf](http://userpage.fu-berlin.de/%7Ehealth/faq_gse.pdf) Accessed [27/01/2013.](#)  
51  
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60

<sup>36</sup> Satia JA, Campbell MK, Galanko JA, et al. Longitudinal changes in lifestyle behaviours and health status in colon cancer survivors. *Cancer Epidemiol Biomarker Prev* 2004;**13(6)**:1022-31.

<sup>37</sup> van der Aalst CM, van Klaveren RJ, de Koning HJ. Does participation to screening unintentionally influence lifestyle behavior and thus lifestyle-related morbidity? *Best Pract Res Clin Gastroenterol* 2010;**24(4)**:465-78doi:10.1016/j.bpg.2010.06.001.

<sup>38</sup> [Newson JT, Huguét N, Ramage-Morin PL, McCarthy MJ, Bernier J, Kaplan MS and McFarland BH, Health behaviour changes after diagnosis of chronic illness among Canadians aged 50 or older. Statistics Canada, Catalogue no. 82-003-XPE • Health Reports, Vol. 23, no. 4, December 2012](#)

<sup>39</sup> Scottish Government, *The Scottish Health Survey: Summary of Key Findings*, Scottish Government, Edinburgh, 2012.

<sup>40</sup> Hepper NG, Drage CW, Davies SF, et al. Chronic obstructive pulmonary disease: a community-oriented program including professional education and screening by a voluntary health agency. *Am Rev Respir Dis* 1980; **121(1)**:97-104.

<sup>41</sup> Ostroff JS, Buckshee N, Mancuso CA, et al. Smoking cessation following CT screening for early detection of lung cancer. *Prev Med* 2001; **33(6)**:613-21.

<sup>42</sup> Brener ND, Billy JO, Grady WR. Assessment of Factors Affecting the Validity of Self-Reported Health-Risk Behavior Among Adolescents: Evidence From the Scientific Literature. *J Adolesc Health* 2003;**33(6)**:436–57.

<sup>43</sup> <http://www.healthscotland.com/topics/settings/health/index.aspx#hphs> Accessed 19/01/2013.

<sup>44</sup> Backer V, Nelbom BM, Duus BR, et al. Introduction of new guidelines for emergency patients: motivational counseling among smokers. *Clin Respir J* 2007;**1(1)**:37-41doi:10.1111/j.1752-699X.2007.00006.x.

<sup>45</sup> Bernstein SL, Boudreaux ED, Cydulka RK, et al. Tobacco control interventions in the emergency department: A joint statement of emergency medicine organizations. *Ann Emerg Med* 2006;**48(4)**:e417-26.

<sup>46</sup> Anderson A; Promoting changes in diet and physical activity in breast and colorectal cancer screening settings: *Cancer Prevention research* 2013;**6(3)**:165-72.

<sup>47</sup> Stead M, Eadie D, Caswell S, Craigie A Anderson AS and the BeWELL team (2012). Understanding the potential and challenges of adenoma treatment as a prevention opportunity: insights from the BeWEL formative study *Prev Med* 2012;**54(1)**:97-103.

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#### Registrations

REC REF 10/S0709/24

UKCRN 9911

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**Contributors:** GH designed and managed the study, obtained ethics approval and drafted the paper. DM designed and managed the study, obtained ethics approval and revised the paper. RO, NC, AC, KS, BD and AB designed the study and revised the paper. LM designed the study, wrote the statistical analysis plan, cleaned and analysed the data and revised the paper. SF advised on the statistical analysis plan and analysed the data. All authors have full

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access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

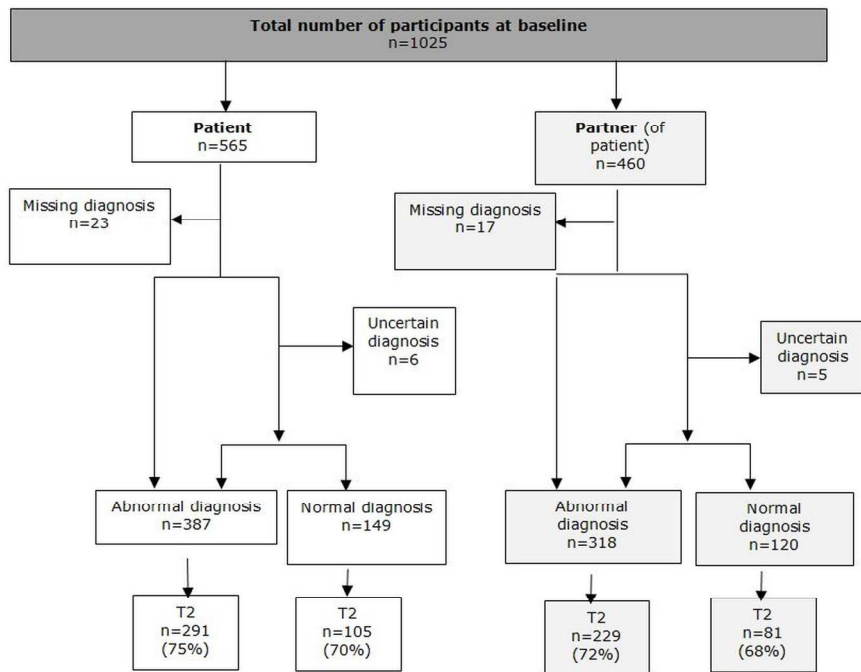
**Competing interests:** All authors had no support from any organisation for the submitted work, no financial relationships with any organisations that might have an interest in the submitted work in the previous three years and no other relationships or activities that could appear to have influenced the submitted work.

**Ethics:** The study received West of Scotland Medical Research Ethics Committee approval (REC REF 10/S0709/24). All participants provided written informed consent. The study was funded by the Chief Scientist Office Scotland and the study sponsor was the University of Stirling. The researchers acted independently from the funder and sponsor.

**Study hypothesis:** The study hypothesis that major health events are teachable moments triggering spontaneous health-related behaviour change arose before inspection of the data. The main hypothesis was that colorectal cancer diagnosis is a teachable moment. This article reports a further study hypothesis, which was that colonoscopy is a teachable moment.

**Data sharing statement:** The relevant anonymised patient level data are available on reasonable request from the corresponding author. Participant consent was not obtained but the presented data are anonymised and risk of identification is low.

Figure 1: Recruitment of participants



249x187mm (300 x 300 DPI)

Review only

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Article
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Y
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Y
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Y
Objectives	3	State specific objectives, including any prespecified hypotheses	Y
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	Y
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Y
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Y
		(b) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Y
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Y
Bias	9	Describe any efforts to address potential sources of bias	Y
Study size	10	Explain how the study size was arrived at	Y
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Y
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Y
		(b) Describe any methods used to examine subgroups and interactions	NA
		(c) Explain how missing data were addressed	Y
		(d) If applicable, explain how loss to follow-up was addressed	Y
		(e) Describe any sensitivity analyses	NA
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Y
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	Y
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Y
		(b) Indicate number of participants with missing data for each variable of interest	Y
		(c) Summarise follow-up time (eg, average and total amount)	-
Outcome data	15*	Report numbers of outcome events or summary measures over time	NA
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear	Y

		which confounders were adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	Y
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	Y
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Y
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Y
Generalisability	21	Discuss the generalisability (external validity) of the study results	Y
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Y

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.