



The relationship between dietary and lifestyle risk factors and colorectal cancer in the Scottish population

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Overview

Colorectal cancer accounts for 13% of all cancer cases and for 10% of all cancer deaths in Scotland. Established risk factors of colorectal cancer (CRC) include personal or family history of CRC as well as some lifestyle and dietary factors. In this briefing, the relationship between CRC and certain food types, nutrients and lifestyle choices is explored based on findings from the Study of Colorectal Cancer in Scotland (SOCCS)¹.

It is important to exercise caution when presenting results on dietary associations with disease, because the study of the relationship between nutrition and health – nutritional epidemiology – has a number of limitations that may not always be clearly reported in the wide media attention that is often given to reports on diet and cancer.

Key points

- High-energy snack foods and high-energy drinks (including sugar-sweetened beverages and fruit juices) have been identified as risk factors for colorectal cancer for the first time. These findings merit further investigation since such snacks and beverages are important contributors to European and North American diets.
- Nutritional epidemiology is a challenging field with a number of limitations resulting in inconsistencies in the published literature.
- Results of dietary association studies should be interpreted with caution since scientific reports on diet and cancer attract wide media attention.

Background

The large intestine's main roles are to absorb vitamins and the remaining water from indigestible food matter, to maintain the fluid balance of the body, and to compact and store faecal material until eliminated through the anus. The main parts of the large intestine are the caecum, the appendix, the colon and the rectum. The colon, which is the largest part, has 4 sections (ascending, transverse, descending and sigmoid) and leads to the final part of the large intestine which is the rectum. Several problems or disorders can arise in the large intestine including irritable bowel syndrome, inflammatory bowel disease, colorectal polyps and colorectal cancer. More than 95% of colorectal cancers are adenocarcinomas with the cancer starting in the gland cells in the lining of the intestinal wall.

There were approximately 4000 colorectal cancer cases (13% of all cancer cases) and around 1500 CRC deaths (10% of all cancer

deaths) in Scotland in 2011 (ISD Scotland) and Scotland has among the highest rates in the UK both for males and females – these rates are age standardised, which means incidence does not reflect whether Scotland has a particularly old population. The established risk factors of CRC include personal or family history of previous CRC or polyps, chronic bowel inflammatory disease and the presence of any of the hereditary syndromes.

Several components of the diet have been linked with either a high or low CRC risk. These include folate, dietary fibre, calcium, fruit and vegetables, vitamin D and red and processed meat. Certain lifestyle habits such as high energy intake, high body weight, low physical activity, smoking and high alcohol intake have been found to be linked to an increased CRC risk, whereas intake of non-steroidal anti-inflammatory drugs (NSAIDs; including aspirin) and intake of hormone replacement therapy (HRT), have been shown to be associated with a reduced CRC and colorectal adenoma risk.

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The study

The aim of this study was to investigate the relationship between CRC and a selection of lifestyle and dietary risk factors in the Scottish population¹. The study included 2,062 patients with CRC and 2,776 individuals without the disease. We recruited about 40% of all CRC patients aged 16 to 79 years presenting between 1999 and 2006 to surgical units in Scotland. Exclusions were: patient too ill to participate; recurrent cases; patient unable to give informed consent due to learning difficulties or other medical conditions; and patient death. During the same period individuals without the disease were drawn from a population-based register and invited to participate. Disease-free participants were matched for area of residence, sex and age with the CRC patients.

The study participants were asked to complete one questionnaire with lifestyle information, where they were asked about their general lifestyle habits including their physical activity, smoking status, any regular intake of aspirin and/or NSAIDs, height and weight. They also completed a food frequency questionnaire used in studies of diet and health in Scotland. Individuals were asked to describe how much and how often they had eaten 150 listed foods. Frequencies of consumption of the specified measures of each food were converted into nutrients using an in-house calculation programme based on the weights of these measures and the nutrient composition of representative foods derived from the UK food composition tables published by McCance and Widdowson's (6th summary edition).

For this analysis, we investigated the relationships between CRC risk and 21 food groups (including among others fruit, vegetables, red meat, breads, eggs, milk, high energy snack foods, sugar-sweetened beverages), 42 nutrients (including among others flavonoids, fatty acids, macronutrients, minerals and vitamins), 7 lifestyle habits (including among others physical activity, obesity, smoking, intake of NSAIDs) and 4 demographic factors (age, sex, family history of CRC and deprivation).

Findings

The foods, nutrients, lifestyle habits or demographic factors that were found to be more strongly linked to a higher risk of CRC in this current analysis were "high-energy snack foods", sugar sweetened beverages (SSBs), eggs, fruit/ vegetable juice, white fish, total caloric intake and a family history of CRC. Those linked to a lower risk of CRC were: coffee, magnesium, and NSAIDs use.

Below, is a brief overview of the current evidence for these factors.

Food groups

High energy snack foods

This study was the first to report a link between high-energy snack foods and increased colorectal cancer risk. "High-energy snack foods" was a summary label that includes high-fat and high-sugar foods, including pudding and deserts, chocolates, nuts and crisps, biscuits and cakes and therefore it represents an unhealthy dietary pattern. This is an important finding that merits further investigation since it has been shown that "high-energy snack foods" accounted for 15% (range 10-20%) of daily energy intake in women and 12% (range 7-19%) in men in 10 European populations². In the UK, the consumption of high-energy snacks has been reported to be increasing and in our study population, it accounted for 20% of the daily energy intake.

Several observational studies have reported associations between CRC and food patterns, which involve the joint analyses of foods that are consumed together by forming clusters of individuals with similar dietary habits (cluster analysis). The two patterns that appear in the majority of the studies are: 1) a pattern of high intake of fruit, vegetables and other healthy foods ("healthy" pattern) and 2) a pattern of high intake of meat, high fat and high sugar foods ("western" pattern). In most studies the "healthy" dietary pattern was found to be associated with a decreased CRC risk, whereas the "western" dietary pattern has been found to be associated with an increased risk.

The positive association between the intake of "high energy snack foods" and CRC is new and remained significant after accounting for physical activity or body mass index (a measure for human body shape based on an individual's weight and height).

Sugar sweetened beverages

We found that high intake of sugar sweetened beverages (SSBs) is linked to a higher CRC risk and this association also remained significant after accounting for physical activity or BMI, and may be linked to the high caloric index of these drinks. The consumption of SSBs has risen dramatically over the last decades in the UK and a recent study showed that their consumption is the highest among adolescents (13–18 years old), but it is also large for adults³. Previous studies have examined the impact of high SSBs consumption on several disease outcomes, including cardiovascular diseases, dental problems, obesity, type 2 diabetes, prostate cancer and pancreatic cancer, but this is the first time that this food group has been linked to CRC.

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Fruit/vegetable juice

A positive link was also found between high consumption of fruit/vegetable juice (which included both fresh and ready-to-drink juice) and CRC, but only in the high BMI group. This would at first appear to be counter-intuitive since this would appear contrary to general health promotional messages on diet and cancer. This food group has rarely been investigated separately in studies of diet and colorectal cancer risk.

Generally, fruit and vegetable juices have different properties to the whole fruit or vegetable they come from, since the majority of them contain sugars, preservatives and other additives. In addition, it has been shown that intake of pure fruit juice raises blood sugar and hence insulin by a greater magnitude than by whole fruit eaten over the same time period, which could account for different metabolic effects. The caloric index of these juices is approximately 38 kcal / 100 ml, which is very similar to that of sugar sweetened beverages (42 kcal/100ml). Therefore, fruit juices could be considered as a class of high-energy drinks, similar to SSBs, and thus might increase CRC risk due to their high sugar or high energy content.

These reported increased risks associated with intake of “high-energy snack foods” and high-energy drinks (including SSBs and fruit/vegetable juices) should be investigated further as their consumption has been reported to be increasing in industrialised countries.

Other foods

An unexpected finding was that there was a link between high intakes of white fish (including fish like cod, haddock, monkfish etc) and high CRC risk. The majority of observational studies have investigated the associations between total fish intake (white fish, oily fish and shellfish) and the findings were inconsistent. A possible explanation of our findings is that 64.3% of the white fish intakes were from fried, cooked in butter or smoked white fish, whereas only 24.3% were from grilled or poached white fish. The cooking preparation of these types of fish generally have a high fat (both saturated and trans fat), heterocyclic amines (formed during frying) or N-nitroso compound (from smoking) content, all of which have been hypothesised to be positively associated with CRC. Also we found that high consumption of eggs was linked to high CRC risk and this might be due to their high content in fat and cholesterol. However, the results from other case-control and cohort studies have been inconsistent.

Finally, we found that high intake of coffee was associated with a decreased CRC risk. That might be due to its high content of particular anticarcinogenic substances, such as phenolic compounds, or because it increases the ability of the large bowel to move freely and pass faecal material. A recent review and meta-analysis of retrospective studies suggested that coffee may be inversely associated with CRC risk (increased coffee linked to decreased risk), but another meta-analysis of 12 prospective studies showed no significant effects of coffee consumption on CRC risk^{4,5}.

Nutrients

Not many nutrients were identified to be linked to CRC based on this analysis. One possible explanation might be that nutrients are usually highly correlated with each other. The only nutrient that was found to be linked to low CRC risk was magnesium. The main food sources of magnesium are green leafy vegetables, nuts, bread, fish, meat, and dairy foods.

However, reported associations between magnesium and CRC risk have been inconsistent.

Demographic characteristics and lifestyle habits

Family history of CRC, high total caloric intake and no or low intake of NSAIDs were also identified to be linked to high CRC risk. Family history is one of the main risk factors of CRC and its link to the disease is well established. On the other hand, the effect of dietary energy intake on CRC risk has been investigated in several observational studies, but the findings are generally inconsistent.

We took a closer look at the intake of non-steroidal anti-inflammatory drugs (NSAIDs; including aspirin): a systematic review of randomised, controlled trials, case-control and cohort studies and a meta-analysis of observational studies, including data from 19 case-control and 11 cohort studies reported that regular use of aspirin or NSAIDs was consistently associated with a reduced risk of CRC, especially in high doses and after use for more than 10 years^{6,7}.

Conclusion

In conclusion the foods, nutrients, lifestyle habits or demographic factors that were more strongly linked to high CRC risk were family history high-energy snack foods, sugar sweetened beverages, fruit/vegetable juice, eggs, total caloric intake and white fish. The factors that were more strongly linked to low CRC risk were intake of NSAIDs, coffee and magnesium. The association between

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“high-energy snack foods” and high-energy drinks (SSBs and fruit juices) and CRC is new and merits further investigation since such snacks and drinks are increasingly important contributors to diets in industrialised country settings.

Implications for policy and research

Establishing causal relationships between dietary factors and common diseases using conventional methods can be problematic. Some of the main limitations of dietary association studies include that the food and nutrient estimations derive from self-reporting questionnaires, where participants are more likely to report healthy than unhealthy behaviors. With self-reporting questionnaires, the study participants may intentionally or unintentionally over- or under-report a particular food item. In addition, we asked participants to complete the food frequency questionnaire for a reference period of approximately a year prior to their diagnosis. However, their dietary habits for even up to 10 years prior to their diagnosis might have affected initiation and progression of the disease, and therefore true changes (that are not captured by the FFQ) within this 10 year period can lead to measurement errors. We observed a difference in participation rates between cases and controls, which might be due to the fact that cases are more eager than population controls to take part in a study that investigates their disease. Therefore in our case, the controls that agreed to participate might have had a healthier diet and lifestyle and therefore were more eager to participate in a case-control study asking about their lifestyle

choices and dietary habits (also known as participation bias). Finally, the size effects were generally small, which means that these foods, nutrients or lifestyle habits only modestly linked to an increased or decreased CRC risk.

Sophisticated statistical and machine data sifting methods that allow the investigation of causality in observational studies and that can overcome the limitations of conventional epidemiological methods have been applied to investigate the causal effects of nutrients on colorectal cancer. These methods, though very promising need very large sample sizes. One other possible, though expensive, solution to these limitations is to conduct single nutrient based randomised-controlled trials for those nutrients for which the observational evidence is promising and may have potentially large public health importance should associations prove to be causal (for example vitamin D supplementation for CRC prevention and/or treatment).

Nutritional epidemiology, the study of the relationship between nutrition and health is a challenging field with a number of limitations resulting in inconsistencies in the published literature. A wide range of nutrients or foods have been suggested to be linked to colorectal cancer and although the evidence has been promising they failed to replicate in future studies. Therefore, the results of dietary association studies should be interpreted with caution, particularly because scientific reports on diet and cancer attract wide media attention that has the power to influence public behaviour.

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