Original research

Lifestyle factors for the prevention of inflammatory bowel disease

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ABSTRACT

Objective To estimate the proportion of cases of Crohn's disease (CD) and ulcerative colitis (UC) that could be prevented by modifiable lifestyle factors.

Design In a prospective cohort study of US adults from the Nurses' Health Study (NHS; n=72,290), NHSII (n=93,909) and Health Professionals Follow-up Study (HPFS; n=41,871), we created modifiable risk scores (MRS; 0–6) for CD and UC based on established lifestyle risk factors, and healthy lifestyle scores (HLS; 0–9) derived from American healthy lifestyle recommendations. We calculated the population attributable risk by comparing the incidence of CD and UC between low-risk (CD-MRS≤1, UC-MRS≤2, HLS≤7) and high-risk groups. We externally validated our findings in three European cohorts: the Swedish Mammography Cohort (n=37,275), Cohort of Swedish Men (n=40,810) and European Prospective Investigation into Cancer and Nutrition (n=404,144).

Results Over 5,117,021 person-years of follow-up (NHS, HPFS: 1986–2016; NHSII: 1991–2017), we documented 346 CD and 456 UC cases. Adherence to a low MRS could have prevented 42.9% (95% CI 12.2% to 66.1%) of CD and 44.4% (95% CI 9.0% to 69.8%) of UC cases. Similarly, adherence to a healthy lifestyle could have prevented 61.1% (95% CI 16.8% to 84.9%) of CD and 42.2% (95% CI 1.7% to 70.9%) of UC cases. In our validation cohorts, adherence to a low MRS and healthy lifestyle could have, respectively, prevented 42.9% (95% CI 12.2% to 66.1%) of CD and 44.4% (95% CI 9.0% to 69.8%) of UC cases. These findings were largely confirmed in three external European cohorts.

Conclusions Across six US and European cohorts, a substantial burden of inflammatory bowel diseases may be preventable through lifestyle modification.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Several modifiable lifestyle and dietary risk factors have been identified for Crohn's disease (CD) and ulcerative colitis (UC) and are widely thought to contribute to disease pathogenesis.
⇒ One approach to the prevention of chronic diseases is via modification of lifestyle and dietary factors.
⇒ However, the extent to which adherence to low-risk factors or a healthy lifestyle could decrease the burden of CD and UC is unknown.

WHAT THIS STUDY ADDS

⇒ In three prospective US cohorts, adherence to low-risk factors could have prevented 42.9% (95% CI 12.2% to 66.1%) of CD and 44.4% (95% CI 9.0% to 69.8%) of UC cases, while adherence to a healthy lifestyle could have prevented 61.1% (95% CI 16.8% to 84.9%) of CD and 42.2% (95% CI 1.7% to 70.9%) of UC cases. These findings were largely confirmed in three external European cohorts.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Assuming a causal relationship exists, a substantial proportion of the burden of inflammatory bowel diseases (IBD) may be preventable through lifestyle modification.
⇒ Lifestyle modification may be an attractive target for future prevention strategies in IBD.

INTRODUCTION

Crohn’s disease (CD) and ulcerative colitis (UC) are chronic inflammatory bowel diseases (IBD) that affect an estimated 3.1 million adults in the USA1 and another 1.3 million in Europe.2 Globally, the incidence of IBD is increasing, particularly in newly industrialised countries.3 IBD is associated with significant societal cost, with an estimated annual healthcare cost of US$23,000 per-person in the USA.4 Thus, strategies to prevent IBD could substantially decrease morbidity associated with disease and healthcare costs. However, to date, no strategies exist to prevent the development of IBD.

One approach to prevent chronic diseases is via modification of lifestyle risk factors. Indeed, previous observational studies have identified several lifestyle factors to be associated with IBD,5,6 but whether modification of these lifestyle factors could be an attractive prevention strategy is unknown. Thus, in this study, we created modifiable risk scores (MRS) based on established risk factors for IBD and estimated the proportion of IBD cases that could have been prevented using population attributable risk (PAR). As some of the established risk factors such as smoking and body mass index...
(BMI) have opposite associations with CD and UC.6,7 We also estimated the proportion of cases that could be prevented by adhering to an overall healthy lifestyle, as recommended by the US Department of Health and Human Services (HHS), the US Department of Agriculture (USDA) and the American Heart Association (AHA).

METHODS

Study population

Our primary cohort included participants from three prospective cohorts: the Nurses’ Health Study (NHS), NHSII and Health Professionals Follow-up Study (HPFS). Briefly, the NHS enrolled 121,700 female nurses (30–55 years) across 11 US states in 1976, while the NHSII cohort, established in 1989, followed a younger cohort of 116,429 female nurses (25–42 years) from 15 US states.8 The HPFS cohort enrolled 51,529 male physicians (40–75 years) across all 50 states in 1986.9 Participants completed baseline and biennial questionnaires that assessed lifestyle factors, anthropomorphic data and medical history. Dietary information was collected every 4 years via semiquantitative food frequency questionnaires (SFFQ) beginning in 1986 for NHS and HPFS and 1991 for NHSII (defined as baseline). Follow-up rates for these cohorts have consistently exceeded 85%.8,9

We excluded participants who had missing baseline SFFQ or implausible daily caloric intake (<600 or >3500 kcal/day for women, <800 or >4200 kcal/day for men; n=67 671 (23%)), those who only completed baseline questionnaire (n=8177 (2.8%)), those with a diagnosis of IBD at baseline (n=144 (0.5%)) and missing or implausible BMI (BMI<10 kg/m²; n=1468 (0.5%)).

We also used three large European cohorts to externally replicate our results: the Swedish Mammography Cohort (SMC; n=37 275), the Cohort of Swedish Men (CoSM; n=40 810) and the European Prospective Investigation into Cancer and Nutrition (EPIC; n=404 144; online supplemental appendix). Briefly, the SMC and CoSM are parallel cohorts of females (40–74 years) and males (45–79 years), respectively, in Sweden, while the EPIC cohort is composed of both males and females (35–70 years) across 10 European countries.10 Detailed medical, lifestyle and dietary information were collected at baseline (1997 for SMC and CoSM, 1992–1999 for EPIC) via self-administered questionnaires in all cohorts (online supplemental appendix).

Patient or public involvement

Patient or the public were not involved in the design or interpretation of this study.

Ascertainment of IBD diagnosis

Ascertainment of IBD diagnoses in NHS, NHSII and HPFS has been previously described in detail.11 Briefly, participants first self-reported diagnoses of either CD or UC in biennial questionnaires. Supplementary questionnaires were then mailed requesting detailed information on IBD diagnoses and permission to review medical records. Records were then reviewed by two gastroenterologists blinded to exposure information. IBD cases were confirmed by endoscopic and histopathology findings and date of diagnosis defined as date of index endoscopy or surgery and pathology results. IBD cases in the validation cohorts were ascertained either through medical record review or validated definitions used in patient registers (online supplemental appendix).

Assessment of lifestyle risk factors and other covariates

Briefly, non-dietary factors including BMI, family history of IBD, history of appendectomy (self-reported), physical activity, smoking status and non-steroidal anti-inflammatory drug (NSAID) use were assessed from baseline and follow-up questionnaires. Dietary factors, including daily servings of fruit and vegetables and red meat, fibre intake in grams (g), and ratio of n3:n6 polyunsaturated fatty acid (PUFA) intake were ascertained using frequency of intake reported on every 4-year SFFQ and the Harvard Food Composition Database to calculate nutrient-level data.12 BMI, smoking status and NSAID use were updated every 2 years, while physical activity and dietary variables were cumulative averaged over the follow-up time to better represent long-term patterns.13 In external cohorts, covariates were ascertained at baseline only. Further details for the variables assessed in the primary and external cohorts are described in the online supplemental appendix.

Statistical analysis

We constructed MRS for each of CD and UC (CD-MRS and UC-MRS) based on established modifiable risk factors, including BMI,6,15 smoking status,7 NSAID use,16 physical activity17 and daily consumption of fruit and vegetables,18 fibre,19,20 n3:n6 PUFA21 and red meat.22 The directed acyclic graph for the proposed relationship between risk factors and outcomes is shown in online supplemental figure S1 (created using DAGitty V 0.3).24 We defined low-risk criteria for each factor based on observed associations from prior literature, some of which had opposite relationships with CD and UC (table 1). For example, never-smoking and non-obese BMI were considered low risk for CD, while current-smoking and obese BMI were considered low risk for UC.6,7,11 For each participant, we assigned 1 point to each factor not meeting its low-risk criterion (0 otherwise) and summed each category for a total MRS of 0–6 points, so that higher scores reflected a greater number of disease-specific risk factors. The low-risk group (reference) was defined as a score 0–1 or 0–2 when there were too few cases of CD and UC (defined by non-convergence of the models) in the 0–1 group.

Additionally, we note that adherence to low-risk factors did not necessarily represent healthy habits, particularly for UC, where current smoking and obese BMI are protective. Thus, we additionally constructed healthy lifestyle scores (HLS), to assess adherence to healthy lifestyle recommendations by the US HHS and USDA Dietary Guidelines for Americans and the AHA Guidelines for Healthy Living25–27 (online supplemental appendix). Healthy criteria were defined as BMI ≥18.5 kg/m²; never smoking; physical activity ≥7.5 metabolic equivalent of task (MET) hours/week.28

### Table 1: Associations between modifiable risk factors and Crohn’s disease or ulcerative colitis, and definitions for ‘low-risk’ criterion used in calculation of modifiable risk scores (MRS)

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>‘Low-risk’ criterion for MRS</th>
<th>‘Low-risk’ criterion for MRS</th>
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</thead>
<tbody>
<tr>
<td>BMI</td>
<td>&lt;30 kg/m²</td>
<td>≥30 kg/m²</td>
</tr>
<tr>
<td>Smoking</td>
<td>Never smokers</td>
<td>Current smokers</td>
</tr>
<tr>
<td>NSAIDs</td>
<td>&lt;2 times/week</td>
<td>&lt;2 times/week</td>
</tr>
<tr>
<td>Physical activity</td>
<td>Highest quintile (MET-hours/week)</td>
<td>Highest quintile (servings/day)</td>
</tr>
<tr>
<td>Fruit and vegetables</td>
<td>Highest quintile (servings/day)</td>
<td>Red meat (servings/day)</td>
</tr>
<tr>
<td>Fibre</td>
<td>Highest quintile (g/day)</td>
<td>n3:n6 PUFA</td>
</tr>
</tbody>
</table>
| BMI, body mass index; MET, metabolic equivalent of task; NSAIDs, non-steroidal anti-inflammatory drugs; PUFA, polyunsaturated fatty acid.

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(MET)-hours/week; intakes of fruit and vegetables ≥8 servings/day, red meat <0.5 servings/day, fibre ≥25 g/day, fish ≥2 servings/week, nuts/seeds ≥0.5 servings/day and alcohol consumption ≤1 drink (14 g/day) (women) or ≤2 drinks (28 g/day) (men; online supplemental table S1). We assigned 1 point for each healthy criterion met, and calculated HLS by summing across all categories (range 0–9), such that higher scores reflected healthier lifestyle. The healthy group (reference) was defined as a score of 7–9, as insufficient number of participants met eight or nine criteria, and the unhealthy group was defined as a score <7.

We calculated person-time from date of return of baseline questionnaire to first of: date of IBD diagnosis, death, date of last returned biennial questionnaire or end of follow-up (2016 for NHS, HPFS; 2017 for NHSIII). We used Cox proportional hazards models to estimate multivariable-adjusted HRs (aHRs) and 95% CIs for CD and UC according to CD-MRS and UC-MRS, respectively, as well as HLS. Models were stratified by age, time period (2-year intervals) and cohort (NHS, NHSII or HPFS) and were additionally adjusted for appendectomy and family history of IBD.4

In analyses that used NHS, NHSII and HPFS data only, all covariates except family history of IBD were modelled as time-varying. However, because EPIC only collected dietary and lifestyle data at baseline, analyses that compared NHS, NHSII and HPFS data with the external cohorts were done using baseline data only.

We calculated the PAR for CD and UC to estimate the proportion of cases that could have been prevented through lifestyle modification, assuming a causal relationship. We used a binary term to compare (1) high-risk with low-risk groups and (2) unhealthy with healthy groups, as has been previously described.28 29 For PAR calculations, exposure prevalence and aHRs were derived separately for each of the pooled NHS, NHSII and HPFS cohorts, pooled SMC and CoSM cohorts and EPIC cohort. In this way, PAR could be interpreted as the proportion of cases in each cohort that could have been prevented if all individuals had been in the (1) low-risk group or (2) healthy group, assuming a causal relationship exists.

We conducted several exploratory and sensitivity analyses. First, we examined whether the relationship between MRS and IBD differed according to sex. Second, because the binary variables in MRS calculation could not account for incremental risk factors with CD and UC differed according to sex. Second, because the binary variables in MRS calculation could not account for incremental risk factors with CD and UC differed according to sex. Second, because the binary variables in MRS calculation could not account for incremental risk factors with CD and UC differed according to sex. Second, because the binary variables in MRS calculation could not account for incremental risk factors with CD and UC differed according to sex. Second, because the binary variables in MRS calculation could not account for incremental risk factors with CD and UC differed according to sex. Second, because the binary variables in MRS calculation could not account for incremental risk factors with CD and UC differed according to sex. Second, because the binary variables in MRS calculation could not account for incremental risk factors with CD and UC differed according to sex. Second, because the binary variables in MRS calculation could not account for incremental risk factors with CD and UC differed according to sex. Second, because the binary variables in MRS calculation could not account for incremental risk factors with CD and UC differed according to sex. Second, because the binary variables in MRS calculation could not account for incremental risk factors with CD and UC differed according to sex. Second, because the binary variables in MRS calculation could not account for incremental risk factors with CD and UC differed according to sex.

Finally, to demonstrate that our scores are further test the specificity of our scores for IBD, we performed additional falsification analyses for two non-immune-mediated diseases, colorectal cancer (CRC) and cardiovascular disease (CVD; online supplemental appendix).

Statistical calculations were performed in SAS V9.4 and STATA V16.1/MP (StataCorp LLC), and statistical significance was defined as p < 0.05 using two-tailed tests. The proportional hazards assumption was tested by including interaction terms between follow-up time and CD-MRS and UC-MRS and testing for significance (CD: p = 0.83, UC: p = 0.08; online supplemental appendix). Residual confounding for the primary analysis was assessed using the E value method (online supplemental appendix).33

RESULTS

In our primary cohort, a total of 208,070 participants were included after exclusions (NHS: n = 72,290, NHSII: n = 93,909 and HPFS: n = 418,711). During 5,117,021 person-years of follow-up, we ascertained 346 CD and 456 UC cases, with an incidence rate of 7 cases of CD and 9 cases of UC per 100,000 person-years. Baseline characteristics for the pooled primary cohort are shown in online supplemental table S2.

Compared with participants with a CD-MRS of 0–1, the aHR (95% CI) of those with a CD-MRS of 6 was 4.15 (1.93 to 8.84; figure 1). Similarly, compared with those with a UC-MRS of 0–2, the aHR (95% CI) of those with a UC-MRS of 6 was 2.78 (1.47 to 5.23). Risk of CD and UC increased with each one-point increase in CD-MRS (pinteraction<0.0001) and UC-MRS (pinteraction=0.008), respectively. Our findings were similar for both women and men (all pinteraction>0.19; online supplemental table S3). When using binary scores, those with a CD-MRS ≥2 had an aHR (95% CI) of 1.85 (1.12 to 3.06; p = 0.02) for CD when compared with those with a score of 0–1. Similarly, those with a UC-MRS≥3 had an aHR (95% CI) of 1.92 (1.08 to 3.40; p = 0.03) for UC when compared with those with a score of 0–2.

We estimated that adherence to low CD-MRS (0–1) and UC-MRS (0–2) could have prevented 42.9% (12.2%–66.1%) of CD and 44.4% (9.0%–69.8%) of UC, respectively (PAR;
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**Figure 2** Risk and PAR of Crohn’s disease according to baseline modifiable risk score for (A) pooled NHS/NHSII/HPFS cohort, (B) pooled SMC/CoSM cohort and (C) EPIC cohort. 4Non-steroidal anti-inflammatory drug data missing from external cohorts, thus maximum MRS=5. 5Cox models adjusted for baseline age (years) and cohort. 6PAR for 2+ risk factors compared with reference (0–1), adjusted for age (<40, 40≤ age <60, ≥60 years) and cohort. aHR, multivariable-adjusted HR; CD, Crohn’s disease; CoSM, Cohort of Swedish Men; EPIC, European Prospective Investigation into Cancer and Nutrition; HPFS, Health Professional’s Follow-up Study; MRS, modifiable risk score; NHS, Nurses’ Health Study; PAR, population attributable risk; SMC, Swedish Mammography Cohort. 76.8%) and 51.2% (0.01% to 80.9%) of CD in the pooled SMC and CoSM cohort and EPIC, respectively. Similarly, for UC, low baseline UC-MRS (0–2) could have prevented 20.6% (−14.5% to 51.0%) and 27.8% (0.001% to 51.6%) of UC in the pooled SMC and CoSM cohort and EPIC, respectively.

We also calculated the proportion of IBD cases that could have been prevented by adherence to American healthy lifestyle guidelines. In the pooled NHS, NHSII and HPFS cohort, baseline HLS was associated with decreased risk of CD and UC (P\textsubscript{trend}=0.004 and 0.02, respectively; table 2). Adherence to a healthy lifestyle (HLS 7–9) could have prevented 48.8% (−37.4% to 89.8%) and 60.4% (4.1% to 87.6%) of CD in the pooled SMC and CoSM cohort and EPIC, respectively, and 56.3% (1.3%–85.1%) and 46.8% (9.7%–72.5%) of UC in the pooled SMC and CoSM cohort and EPIC, respectively.

Additionally, we explored the contribution of individual lifestyle factors and risk of CD and UC in our primary cohorts (online supplemental tables S5 and S6). Low fibre intake conferred the largest PAR for CD (27.9%) followed by past or current smoking (14.4%) and low physical activity (12.9%; online supplemental table S7). Low fruit and vegetable intake contributed the largest PAR for CD (27.9%) followed by past or current smoking (18.0%) and low n3:n6 PUFA (11.0%; online supplemental table S7). In comparison, family history of IBD conferred a PAR of 12.2% (8.0%–16.2%) for CD and 8.8% (5.4%–12.1%) for UC.
In three large prospective US cohorts, we demonstrate that modifiable lifestyle factors could substantially decrease the burden of IBD. We found that 43% of CD and 44% of UC cases could have been prevented by adhering to low-risk modifiable lifestyle factors, assuming a causal relationship exists. Moreover, adherence to American healthy lifestyle recommendations could have prevented 61% of CD cases and 42% of UC cases. These findings were consistent across three European cohorts. In comparison, in our primary cohorts, family history of IBD had a modest contribution of modifiable lifestyle and dietary factors to the risk of CD and UC. Nonetheless, our estimates are similar to those published for other immune-mediated diseases. For example, in two prior studies, modification of lifestyle risk factors could have prevented 41% of RA and 48% of psoriasis cases. Further, similar to our study, family history had only a modest contribution to the risk of RA and psoriasis (~20% each).

Finally, we used the E value method to assess for residual confounding in the relationship between binary MRS scores and IBD. We estimated that current tobacco use conferred a 47% attributable risk for CD. To our knowledge, our study represents the first to comprehensively assess the contribution of modifiable lifestyle and dietary factors to the risk of CD and UC. Nonetheless, our estimates are similar to those published for other immune-mediated diseases.
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and UC. While unhealthy factors such as obesity and smoking have been inversely associated with risk of UC,6,38 we saw that their contribution was outweighed by the total effect of healthy living. That is, more UC cases could have been prevented by adherence to a healthy lifestyle (42%–56%) as compared with adherence to ‘traditional’ UC risk factors assessed by our UC-MRS scores (21%–44%). Thus, current guidelines for healthy living, which are primarily recommended to reduce CVD risk, may have additional benefits for prevention of other immune-mediated diseases such as IBD.

A key assumption of our findings is that the relationship between lifestyle factors and IBD development is causal. Though this has yet to be established, several lines of evidence support the critical role of environmental and lifestyle factors in development of IBD. First, in genome-wide association studies, genetic factors account for less than 13% of the total variance of IBD.34 Similarly, in monozygotic twins, concordance for disease is estimated to be around only 15% for UC and 30% for CD.40,41 Second, the high incidence of IBD in industrialised societies and sharp rise of IBD in developing countries also suggest that Westernisation of diet and environment influences disease development.3 Further, in immigrants who move from low-incidence to high-incidence countries, risk for IBD is higher in second-generation than first-generation immigrants.52 Finally, the dietary and lifestyle factors considered here have also been linked with systemic inflammation, microbial dysbiosis and gut permeability, providing mechanistic plausibility for a causal relationship.40,44 Thus, although family history of IBD was the single strongest risk factor for IBD in our cohorts (aHR (95% CI)=4.53 (3.38 to 6.07) for CD and 3.24 (2.45 to 4.29) for UC), the collective impact of environmental factors on IBD development is likely greater.

Though there are currently no known disease prevention strategies for CD and UC, dietary and lifestyle modifications may change the immunologic and microbiologic milieu necessary for disease development and therefore could serve as a strategy for IBD prevention. This may be of particular relevance to high-risk groups, such as first-degree relatives of IBD patients, who have an estimated 2%–17% risk of developing the disease over their lifetime.45 Similar strategies have been applied in other immune-mediated diseases, including type 1 diabetes48 and in unaffected first-degree relatives of those with RA.49

Our study has several strengths. Exposure data were collected prospectively, minimising the risk of recall or selection bias. Diet and physical activity variables were cumulatively averaged to account for long-term patterns. We used validated methods to assess lifestyle factors across all cohorts,40,51 and updated them over time to minimise exposure misclassification. Compared with prior studies, we considered a comprehensive list of modifiable lifestyle factors in the quantification of PAR, and avoided use of non-modifiable factors, preclinical markers of disease and surrogates for proximal disease exposures in our MRS.52 Further, falsification analysis demonstrated that our scores are relatively specific for IBD. For example, though the associations and PAR estimates were similar for RA, a chronic immune-mediated disease with shared risk factors for CD, the corresponding PARs, and therefore preventable cases, were lower in CRC and CVD in spite of similar direction of association. This is largely due to differences in strength of associations and prevalence of risk factors, and presence of other modifiable risk factors such as alcohol and medications or supplements which are strongly associated with these other conditions.29,53 We also note that the follow-up period in our cohorts coincided with a significant rise in the incidence of IBD in the Western countries, allowing us to examine relevant secular changes in lifestyle and dietary behaviours.3 In our primary cohorts and EPIC, cases of IBD were confirmed through blinded, medical record review by two gastroenterologists, minimising outcome misclassification bias. Additionally, while several PAR values had wide CIs, potentially due to a limited number of cases or a high SE introduced by a broad exposure definition,52 the large majority did not cross 0%, increasing confidence in potential importance of dietary and lifestyle modifications in preventing CD and UC.

Finally, our findings were largely reproducible in three European prospective cohorts, confirming external validity.

We also acknowledge several limitations. Mean age of IBD diagnosis (~45 years) for our cohort was higher than the typical age of onset of IBD, thus younger onset disease may be underrepresented. Given the stronger genetic association with early-onset disease,54 our PAR figures may overestimate the potential for lifestyle modifications in preventing early-onset IBD. Nonetheless, this finding may remain relevant for older-onset disease, which may be driven more heavily by environmental and lifestyle factors. Early lifestyle factors such as antibiotic exposure and breast feeding, which have not been associated with IBD risk in these cohorts,55 environmental factors including pollution and socioeconomic factors were also not considered as these may not be readily modifiable.42 We also acknowledge that we did not have information on several other potentially modifiable factors such as stress in our cohorts. Thus, residual confounding may exist and affect the validity of PAR estimates if all confounders are not modelled.28,52 However, as most observed relationships between environmental and lifestyle factors and risk of IBD rarely exceed relative risk ratios of 3.00,56 we feel the E value analysis for residual confounding builds confidence in the validity of our results. We note that longitudinal data were not available for all cohorts thus time-varying exposures could not be used in our external cohorts. PAR is also affected by exposure prevalence, which may differ across non-Western countries, and therefore generalisability may be limited. Finally, because of our limited sample size, we could not independently explore the contribution of modifiable lifestyle factors to risk of IBD in high-risk individuals, defined as those with a first degree relative with IBD.

CONCLUSION

Across six US and European cohorts, we confirmed that a substantial proportion of CD and UC risk may be preventable through modification of lifestyle risk factors or adherence to a healthy lifestyle. Further prospective interventional studies are needed to determine whether lifestyle modification is effective for the primary prevention of IBD, particularly in high-risk population and younger-onset disease.

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Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Further information including the procedures to obtain and access data from the Nurses’ Health Studies and Health Professionals Follow-up Study is described at https://www.nurseshealthstudy.org/researchers (contact email: nlhsaccess@channing.harvard.edu) and https://sites.sph.harvard.edu/hfps/for-collaborators/.

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