

Supplement to: Kang L, Yan W, He J, Sun H, Jing W, Liu J, Liu M, Liang W, Dong J. Global incidence patterns of early-onset gastrointestinal cancers and their ecological associations with behavioural risk factors. J Glob Health. 2026;16:04163.

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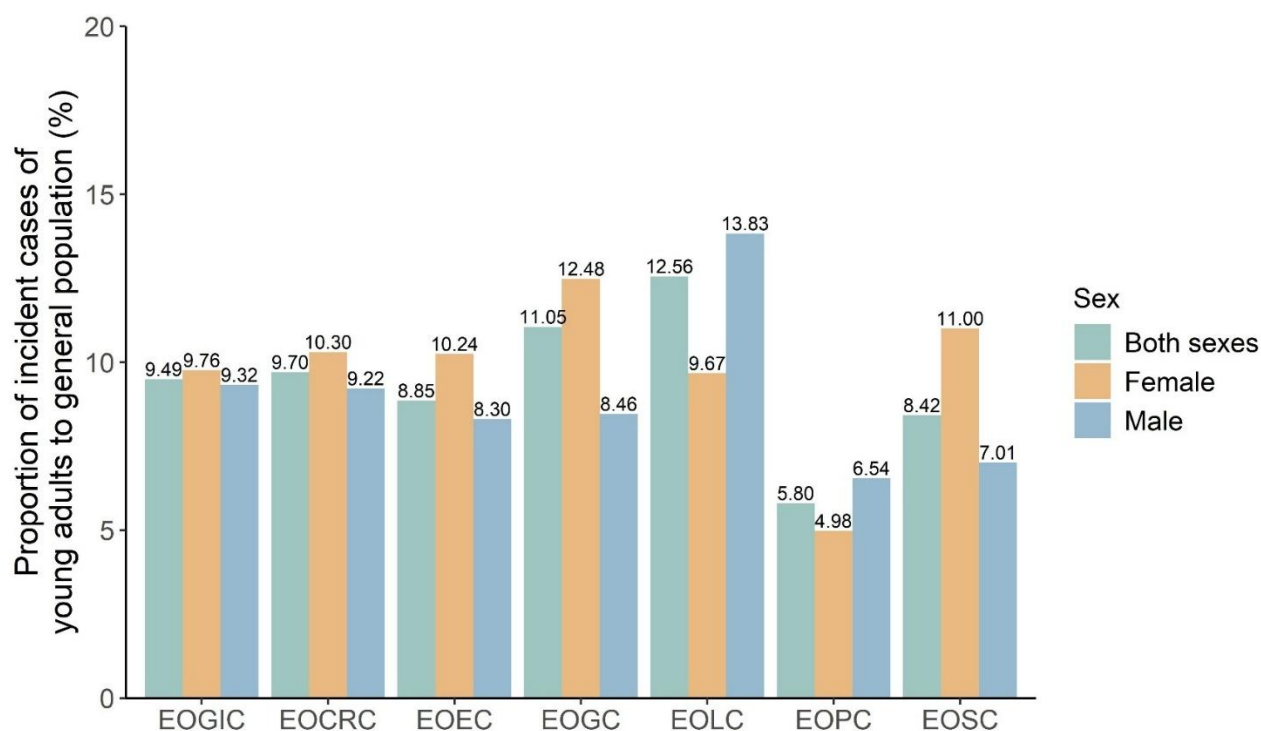


Figure S1 Proportion of incident cases of early-onset gastrointestinal cancers to overall gastrointestinal cancers.

EOGIC: early-onset gastrointestinal cancer; EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer.

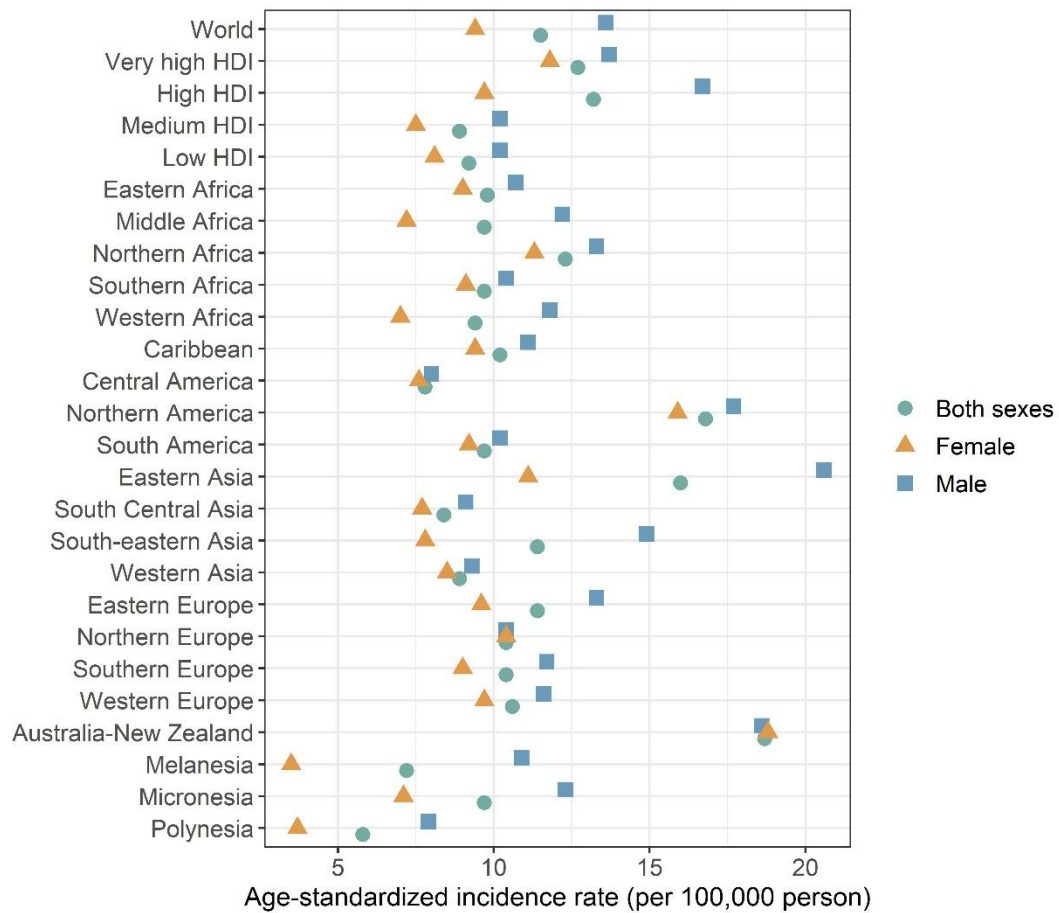


Figure S2 The age-standardized incidence rates for total early-onset gastrointestinal cancers in different regions in 2022.

HDI: human development index

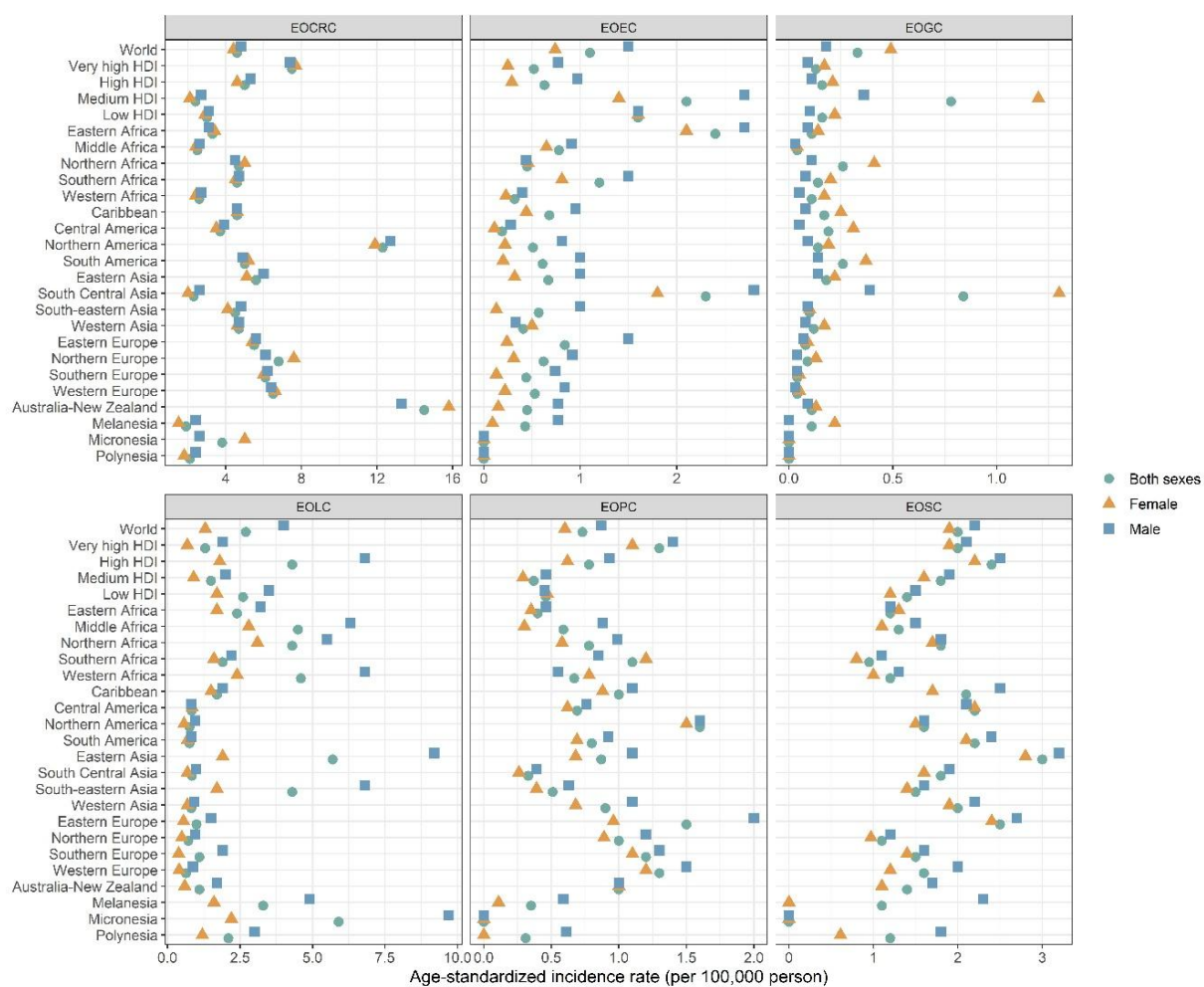


Figure S3 The age-standardized incidence rates for six types of early-onset gastrointestinal cancers in different regions in 2022.

EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer; HDI: human development index.

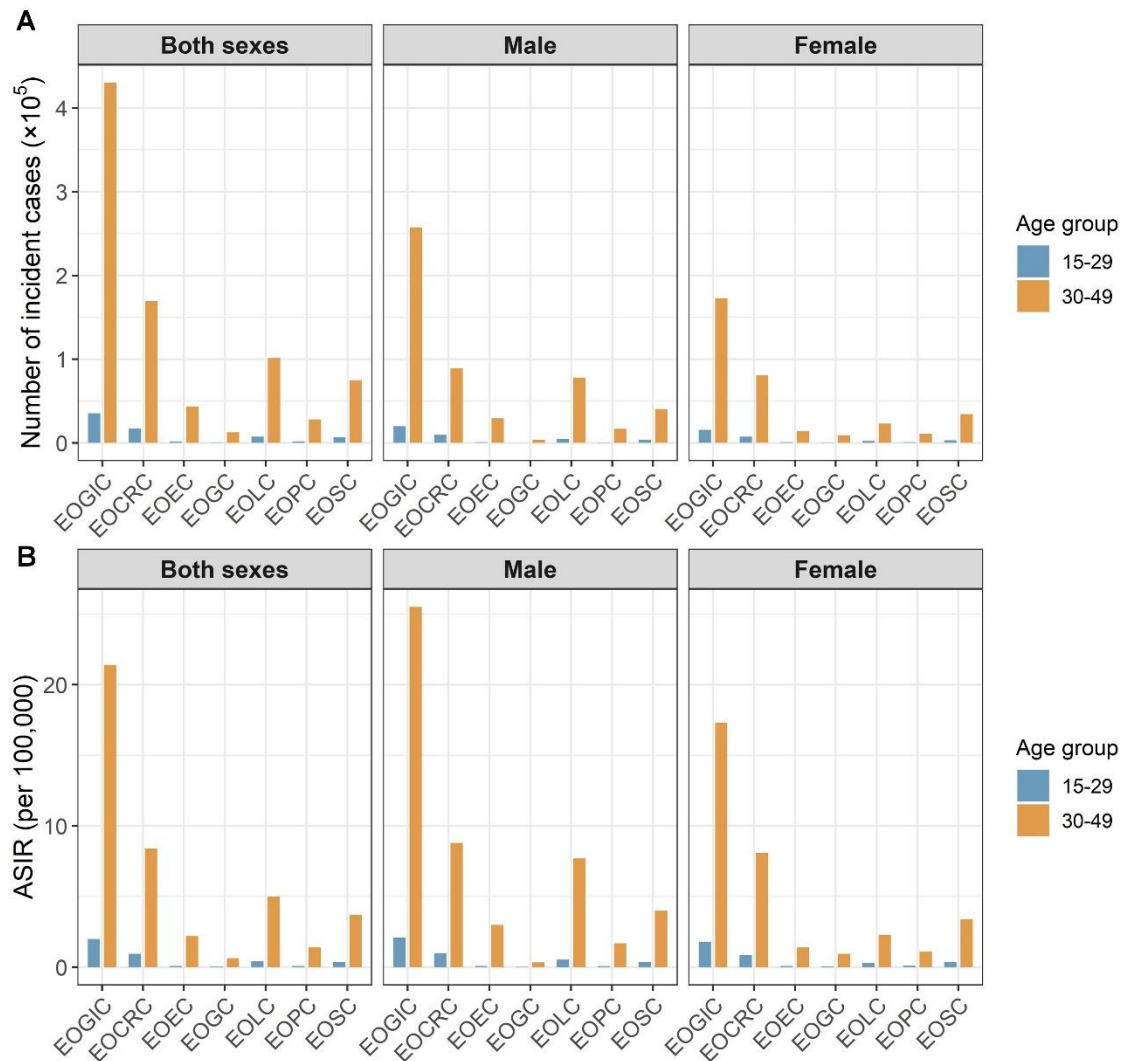


Figure S4 The incident cases and age-standardized incidence rates for early-onset gastrointestinal cancers in 2022 by age and sex. A: number of incident cases; B: age-standardized incidence rates.

ASIR: age-standardized incidence rate (per 100,000 persons); EOGIC: early-onset gastrointestinal cancer; EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer; HDI: human development index.

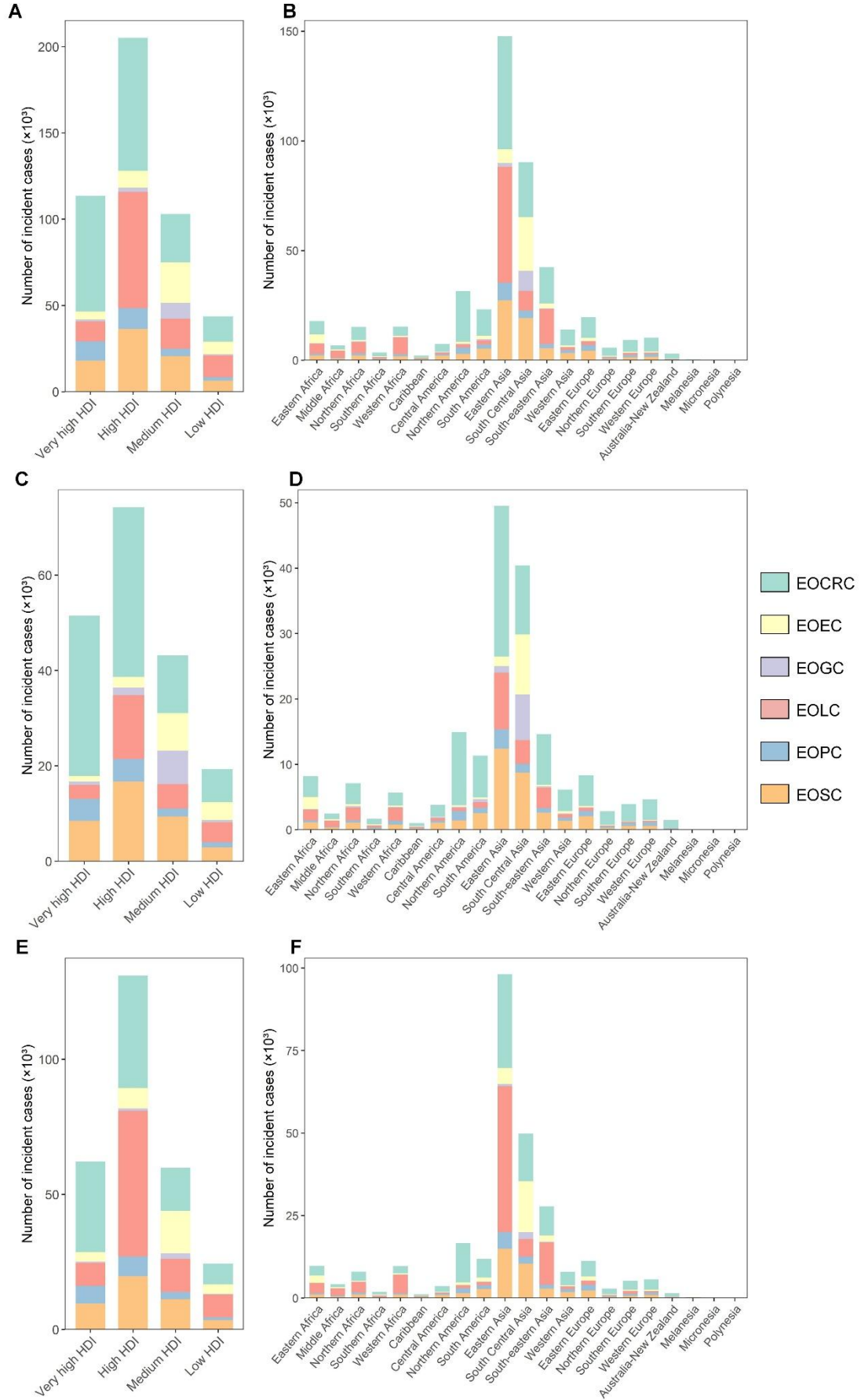
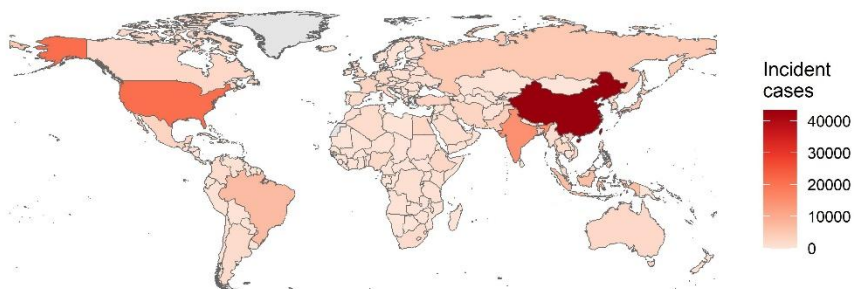


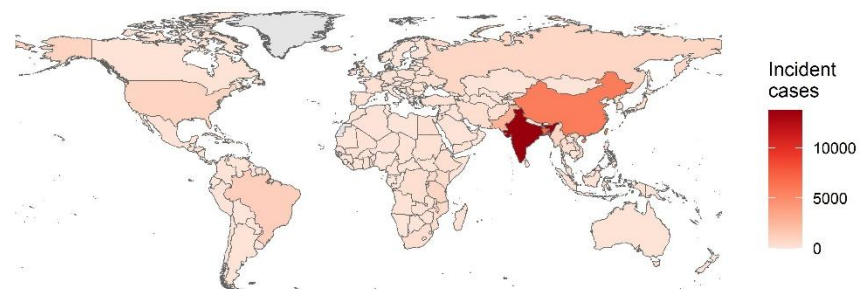
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EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer; HDI: human development index; UN: United Nations.

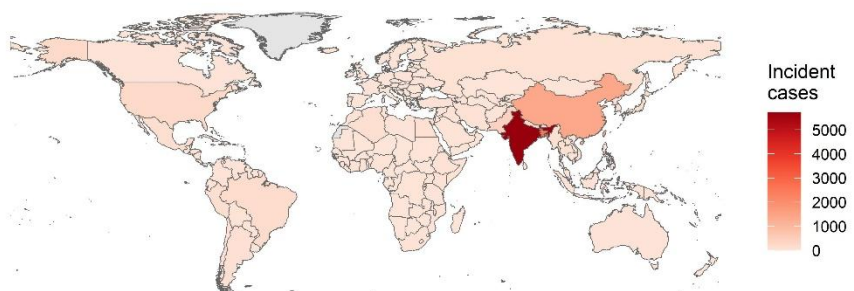
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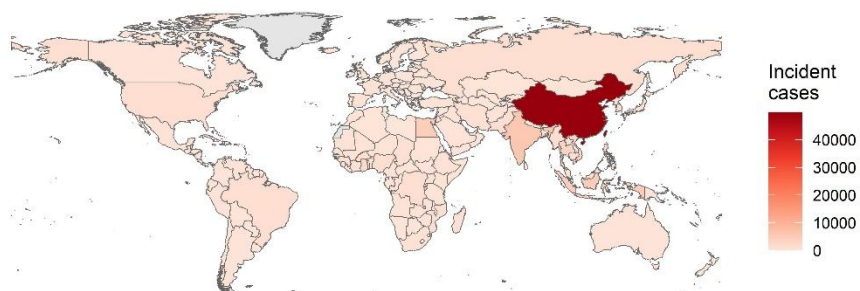
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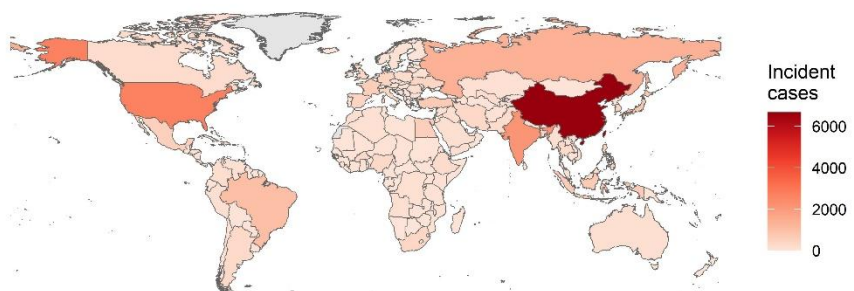
EOGC



EOLC



EOPC



EOSC

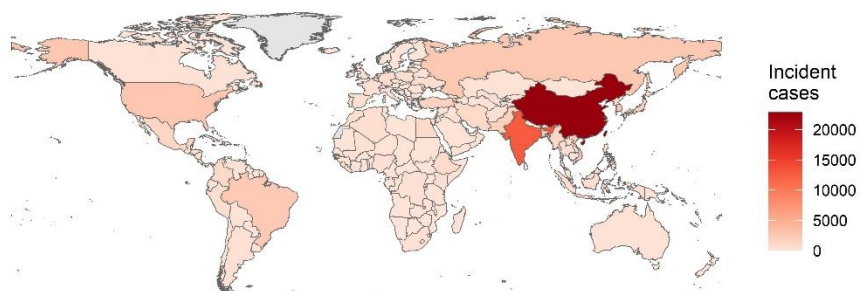
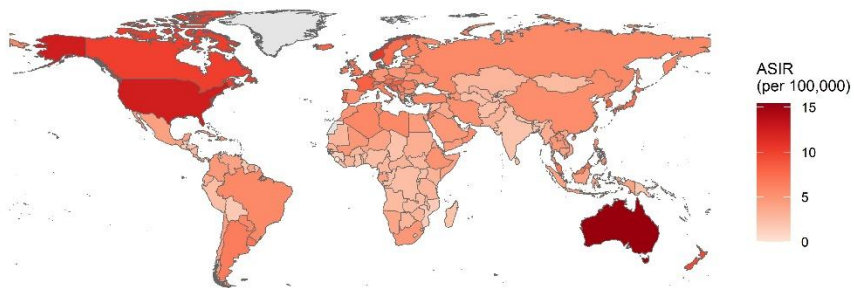


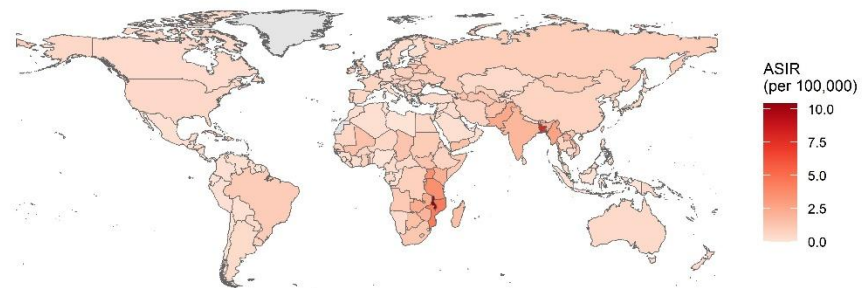
Figure S6 The number of incident cases for six types of early-onset gastrointestinal cancers in 2022 by country.

EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer.

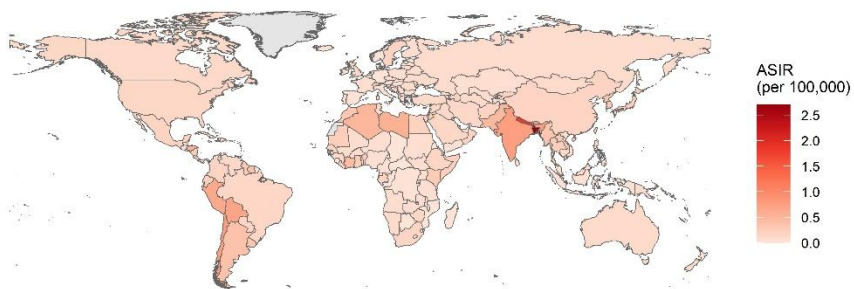
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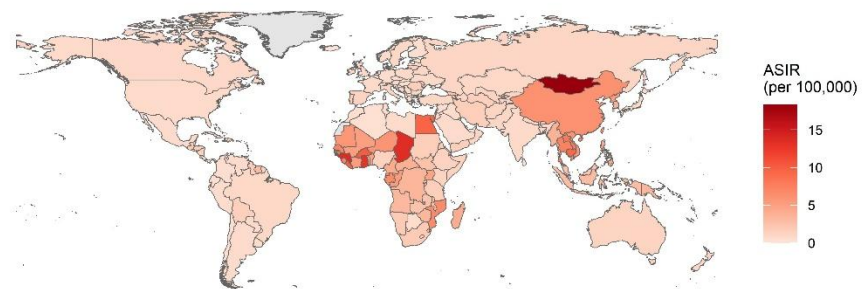
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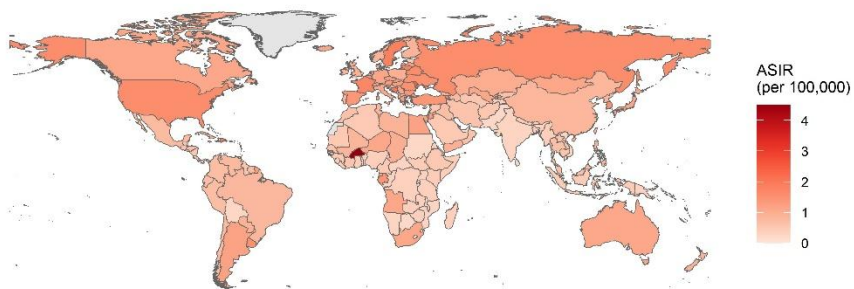
EOGC



EOLC



EOPC



EOSC

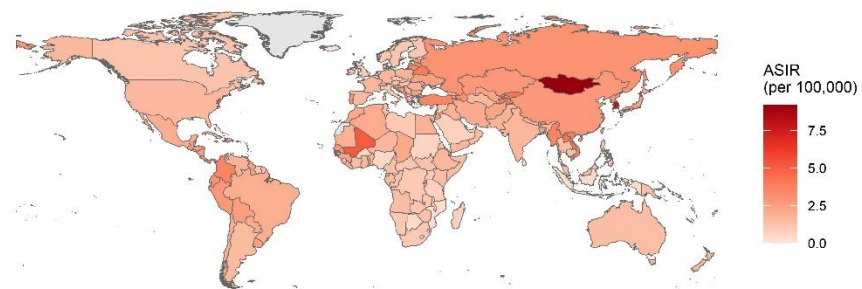


Figure S7 The age-standardized incidence rates (per 100 000 persons) for six types of early-onset gastrointestinal cancers in 2022 by country. EOCRC – early-onset colon and rectum cancer; EOEC – early-onset oesophageal cancer; EOGC – early-onset gallbladder cancer; EOLC – early-onset liver and intrahepatic bile ducts cancer; EOPC – early-onset pancreatic cancer; EOSC – early-onset stomach cancer.

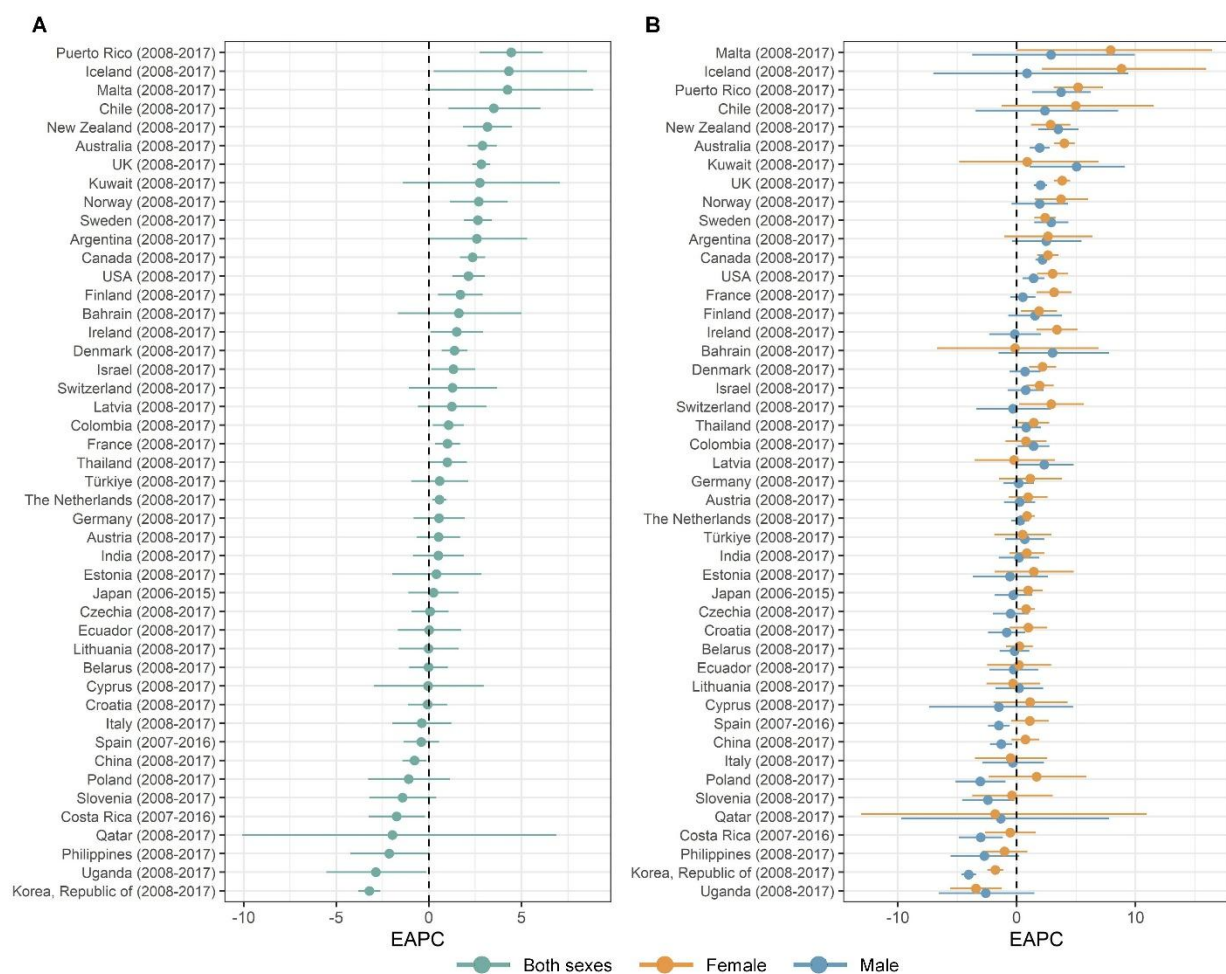


Figure S8 Ten-year trends in age-standardised incidence rates of total gastrointestinal cancer among different countries. **Panel A.** EAPCs among both sexes. **Panel B.** EAPCs among females and males. EAPC – estimated average percentage change.

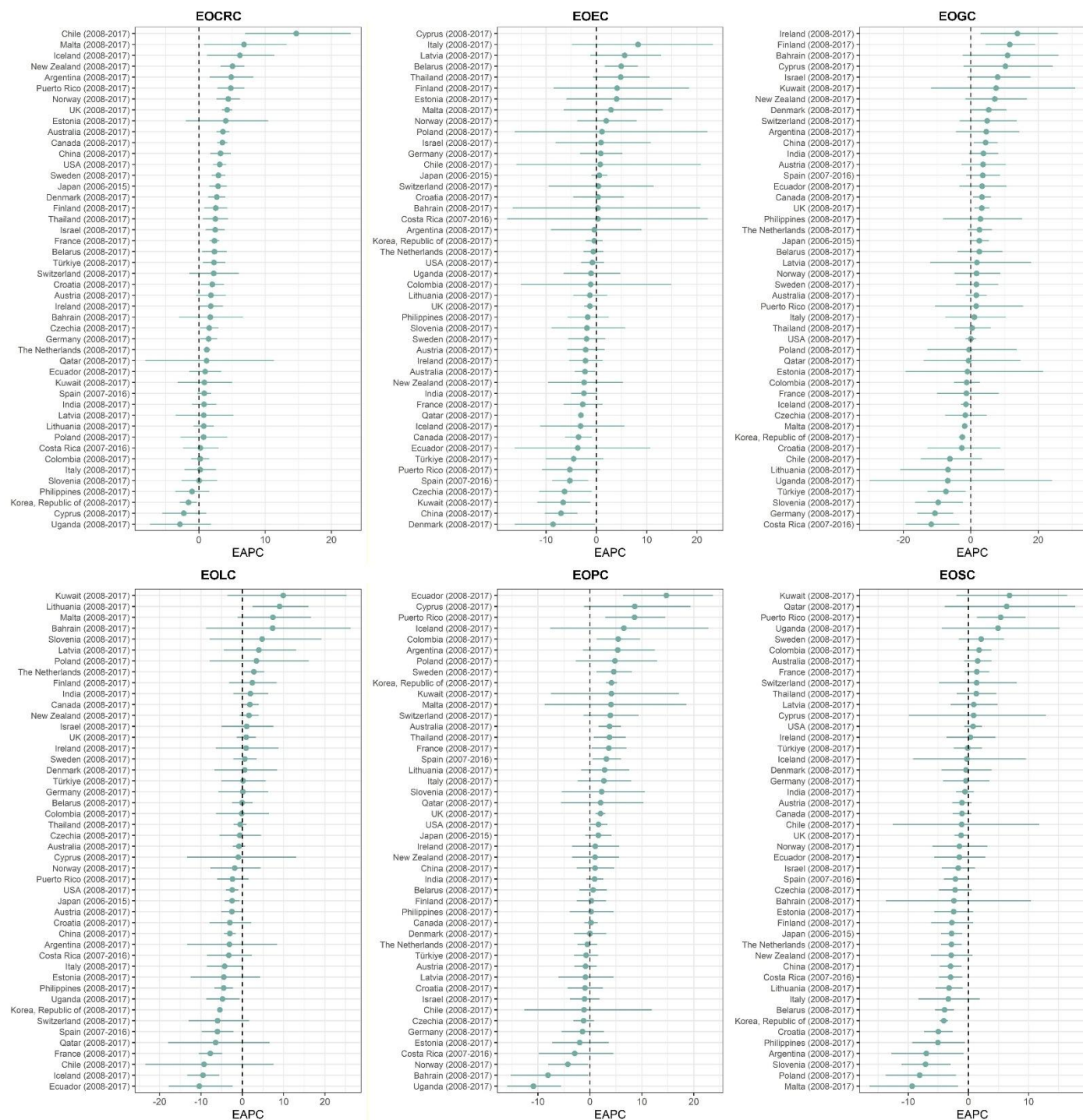


Figure S9 Ten-year trends in age-standardized incidence rates of six types of gastrointestinal cancers among 46 countries.

EAPC: estimated average percentage change; EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer.



Figure S10 Ten-year trends in age-standardized incidence rates of six types of gastrointestinal cancers by sex among 46 countries.

EAPC: estimated average percentage change; EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer.

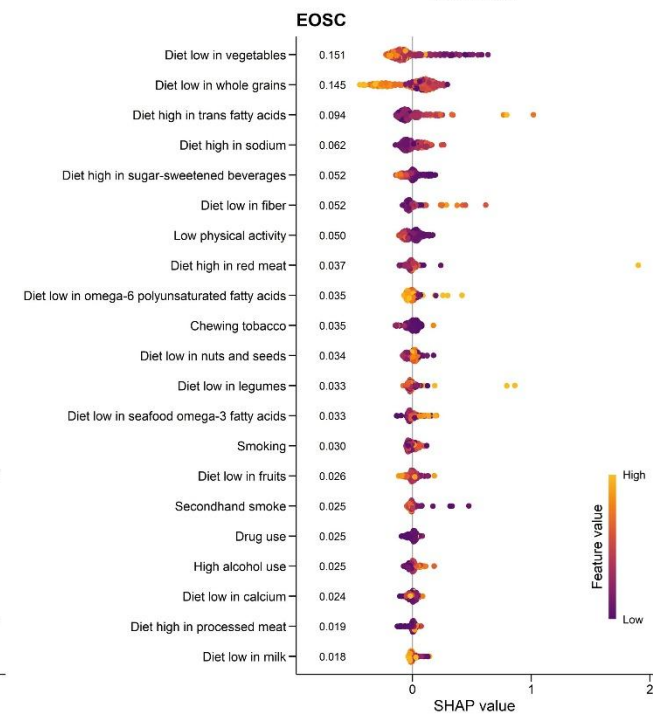
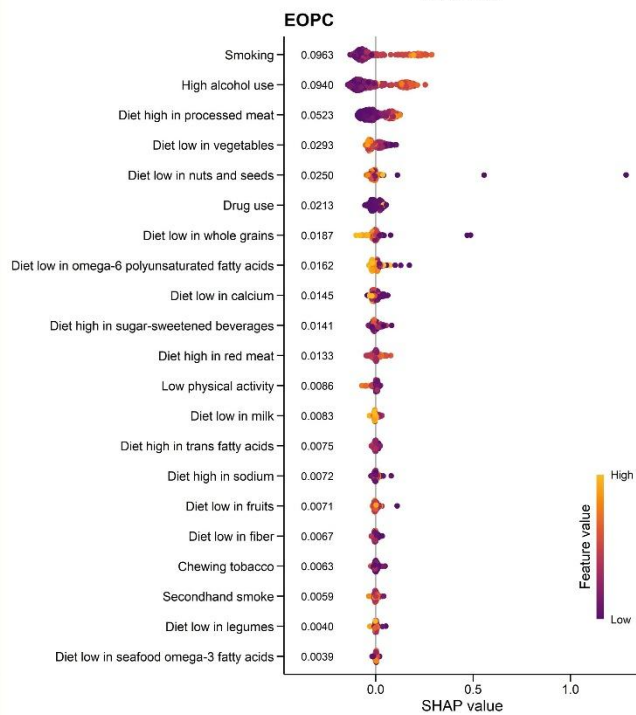
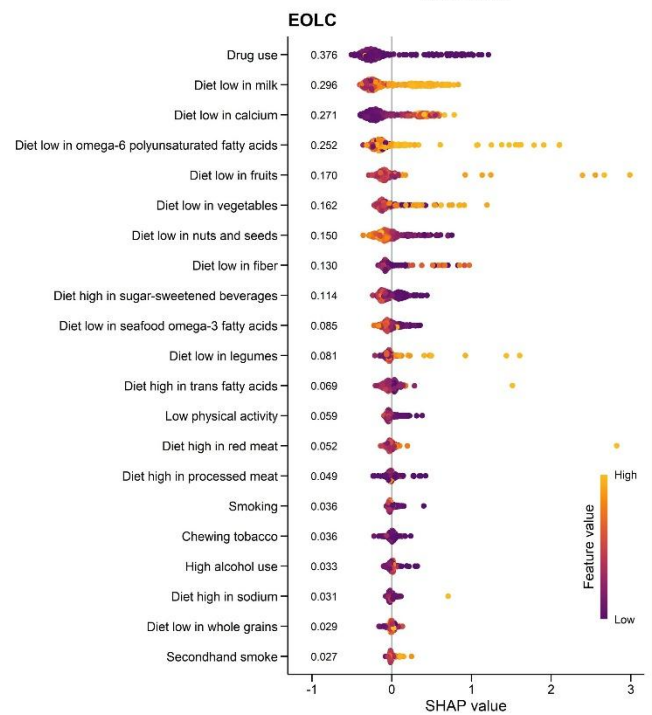
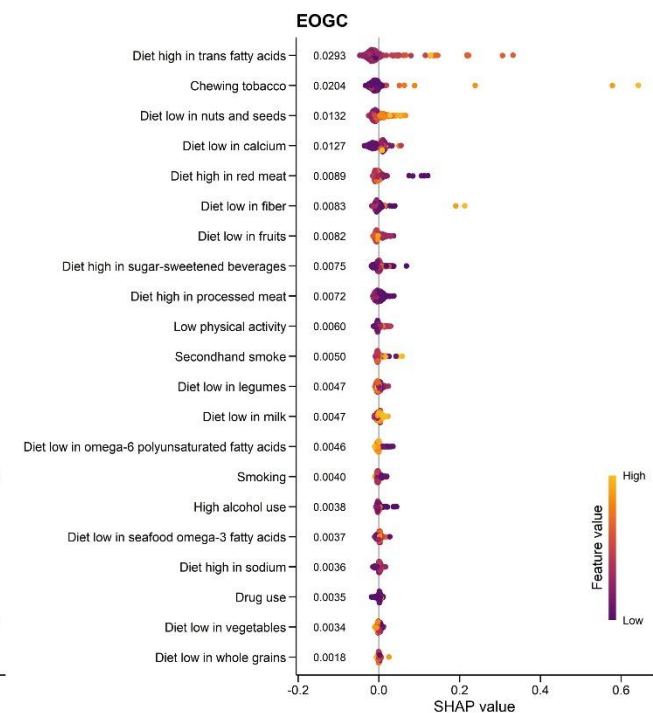
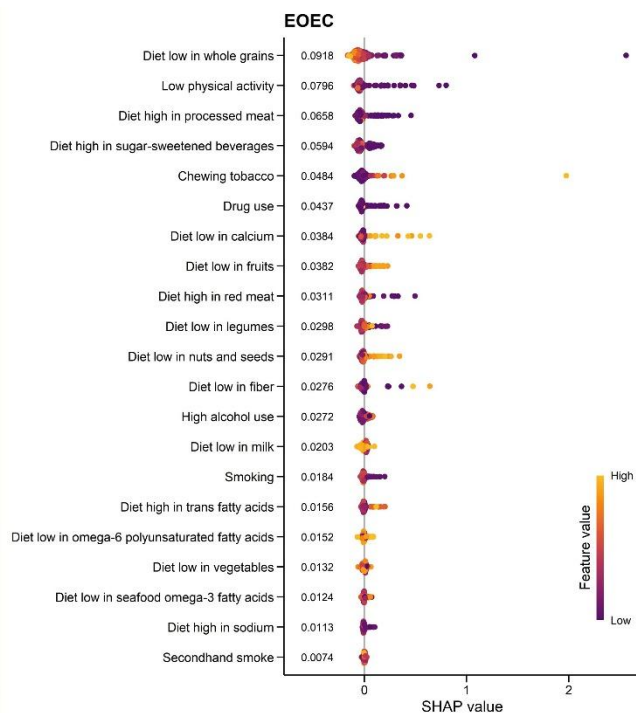
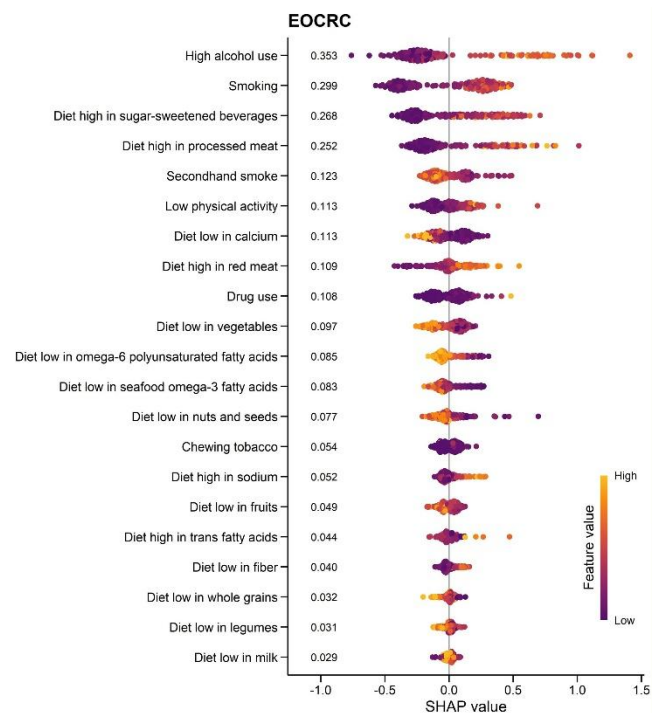


Figure S11 SHAP summary plot illustrating the impacts of behavioral risk factors on six types of early-onset gastrointestinal cancers.

EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer; SHAP: Shapley additive explanations.

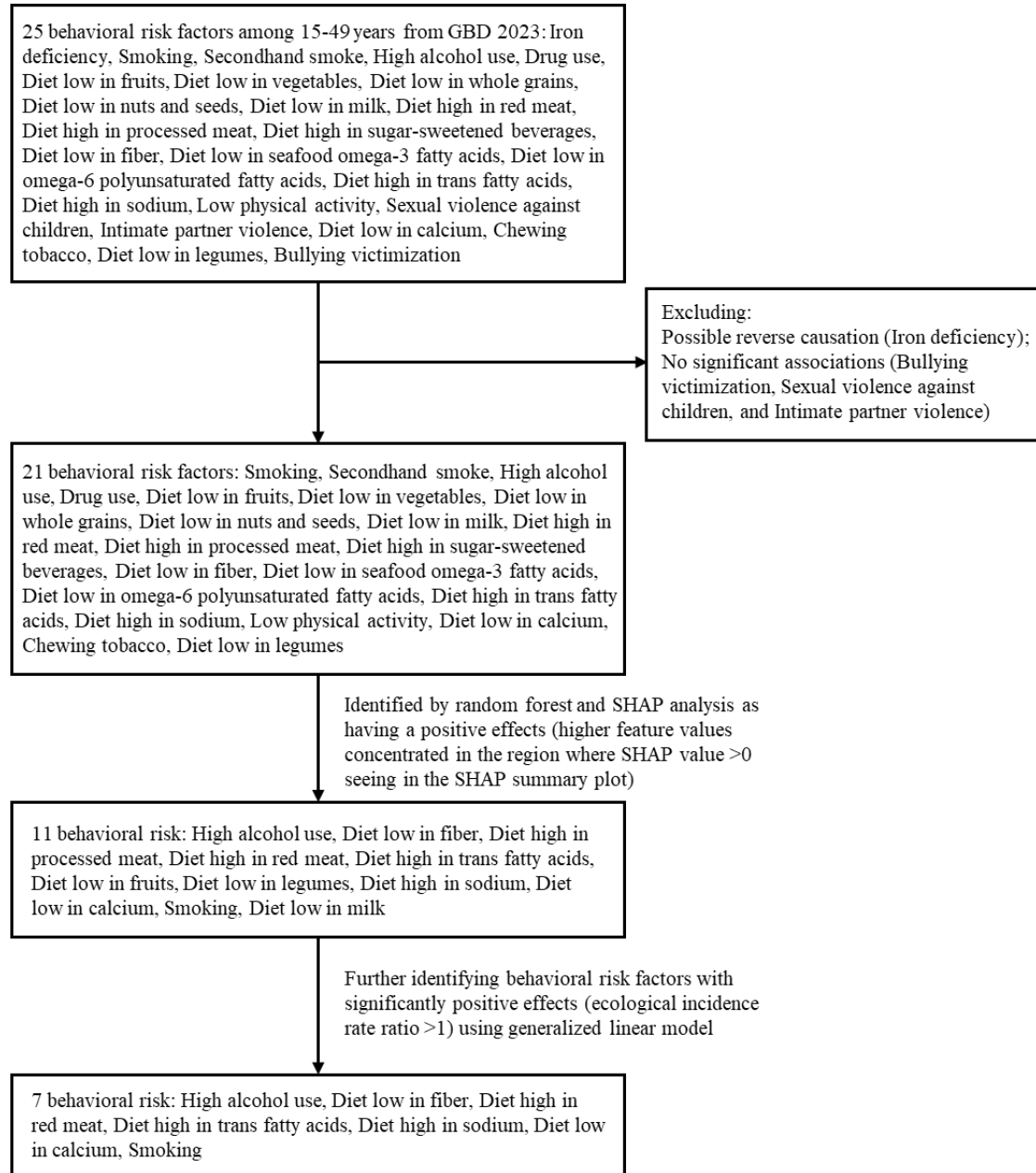


Figure S12 The selection flowchart of behavioral risk factors for EOGIC.

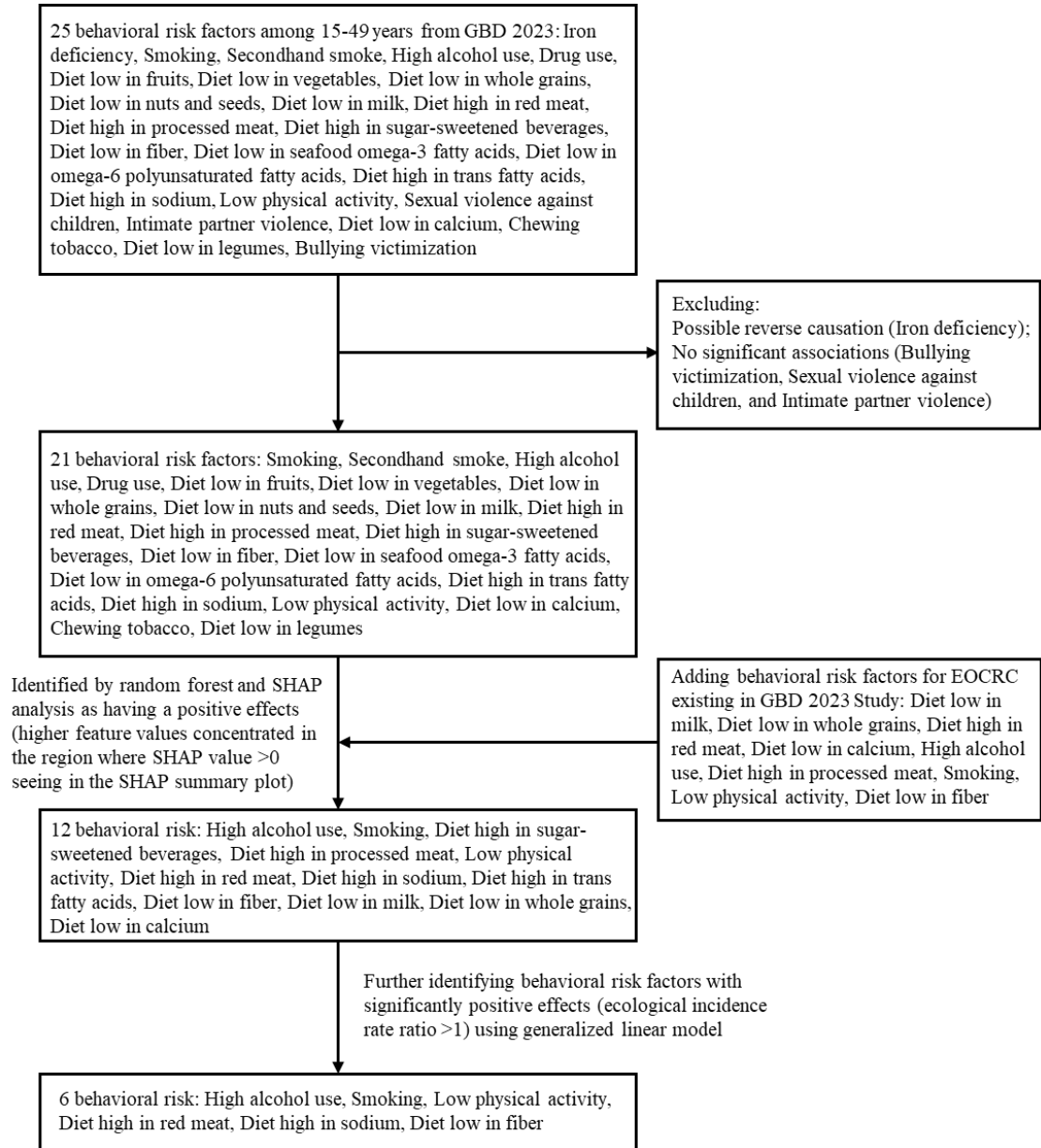


Figure S13 The selection flowchart of behavioral risk factors for EOCRC.

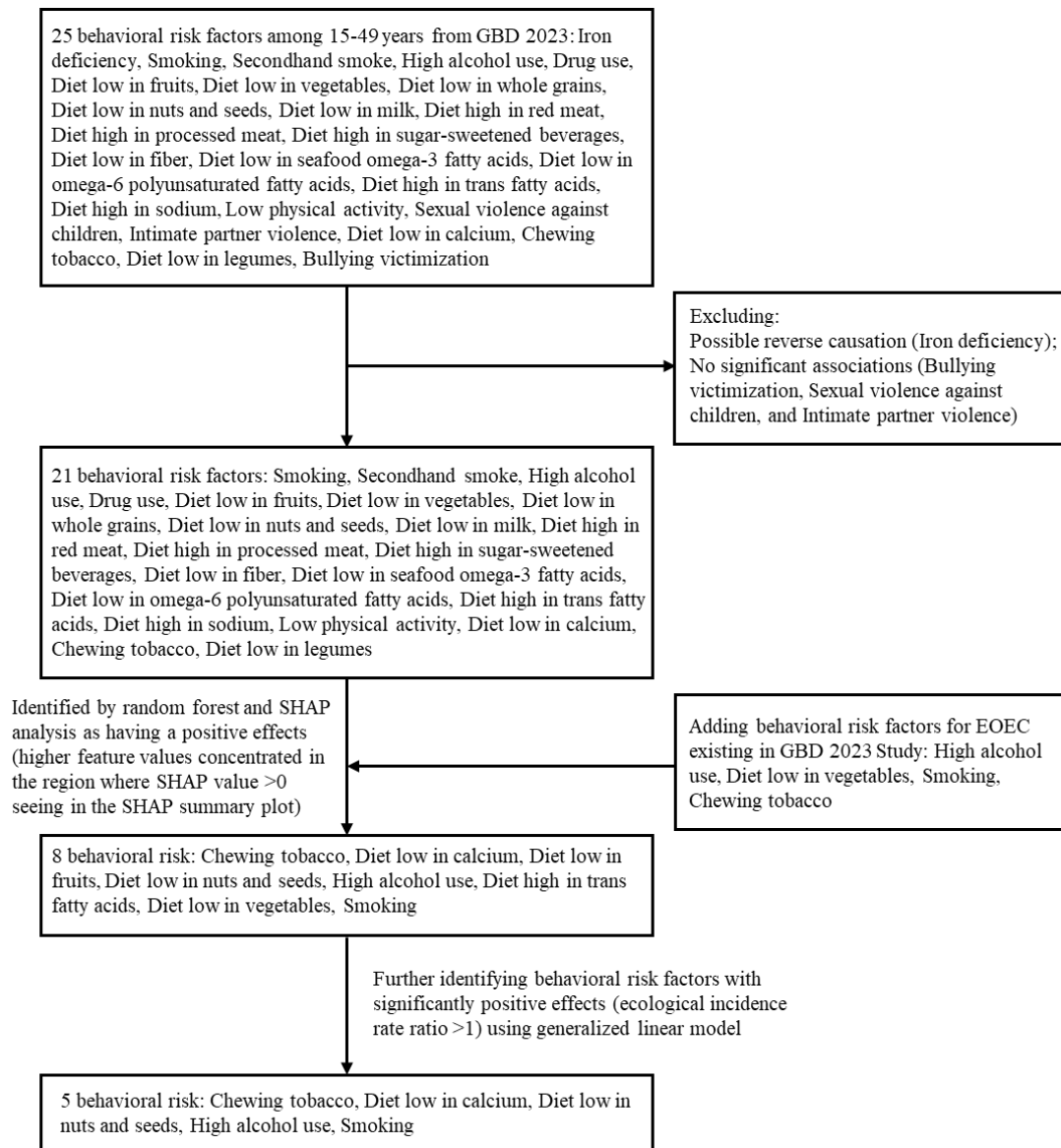


Figure S14 The selection flowchart of behavioral risk factors for EOEC.

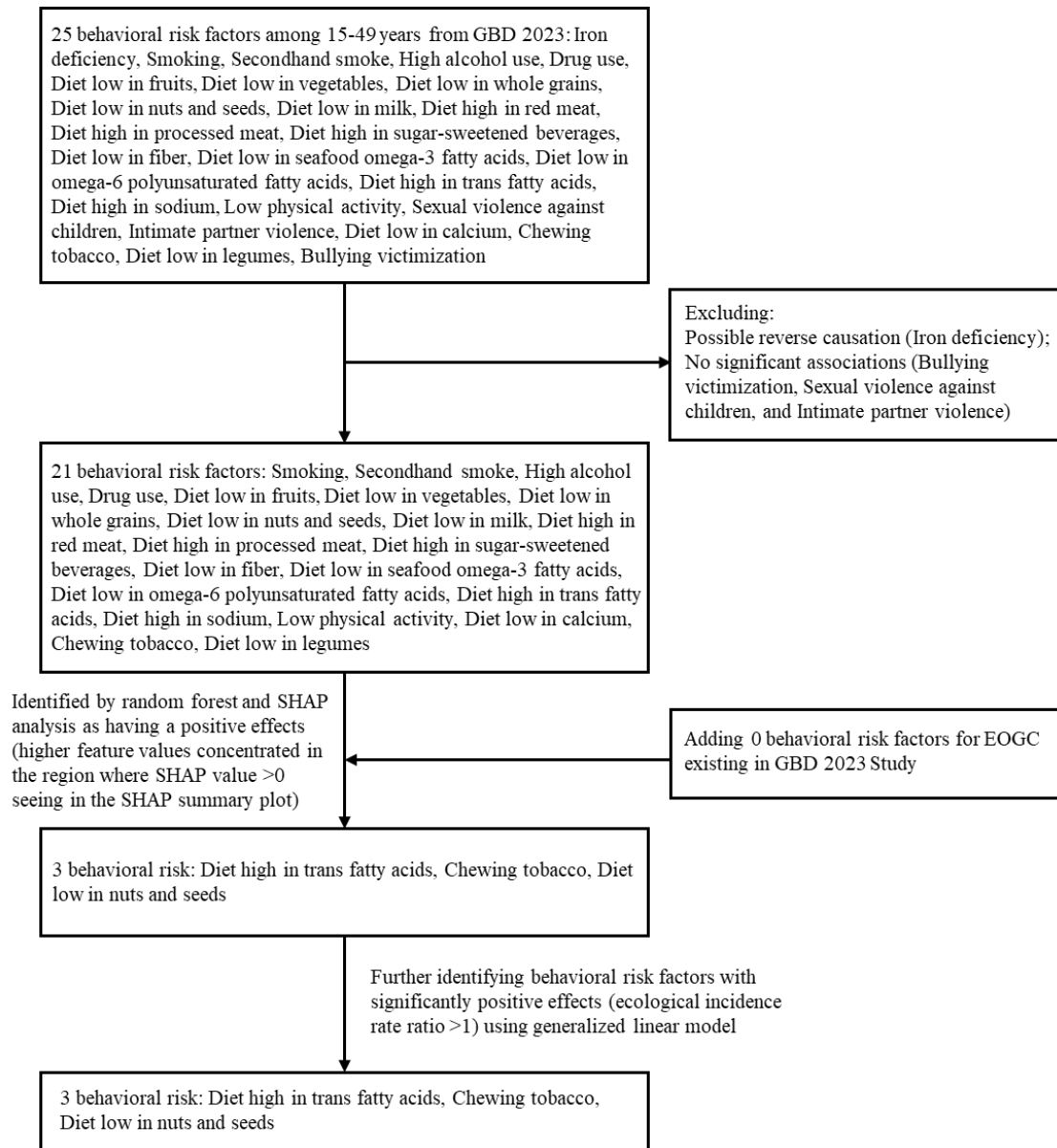


Figure S15 The selection flowchart of behavioral risk factors for EOGC.

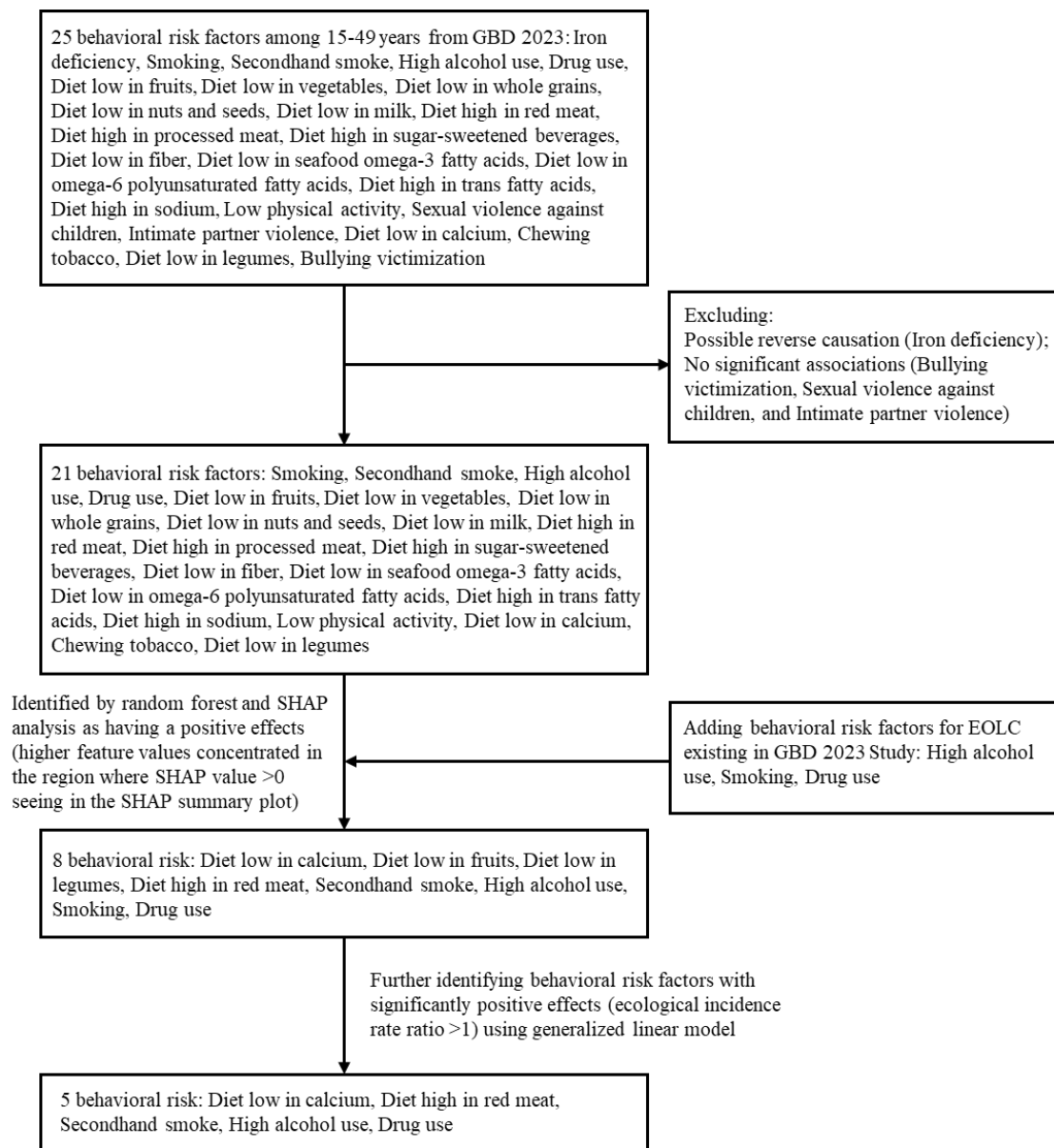


Figure S16 The selection flowchart of behavioral risk factors for EOLC.

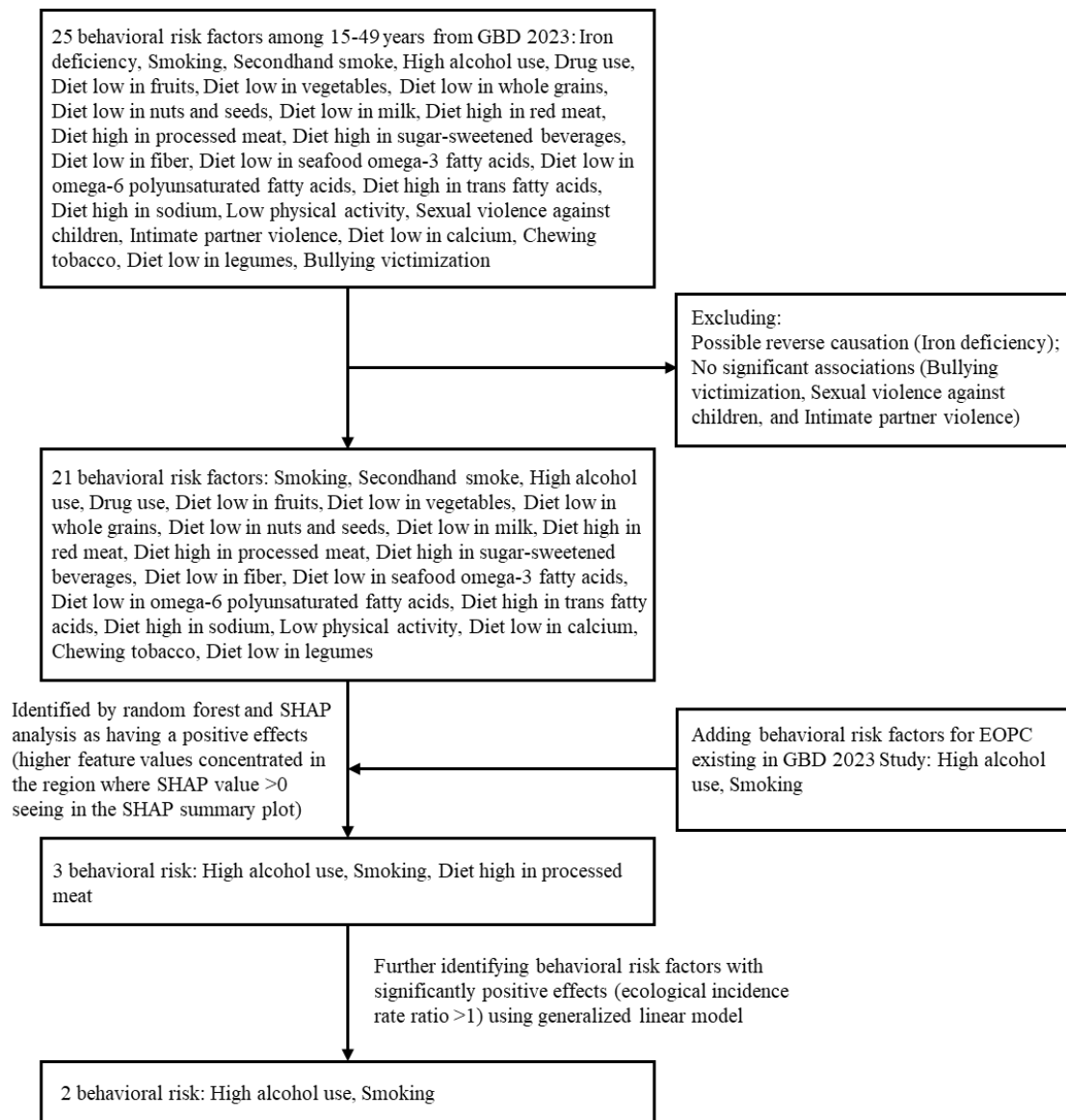


Figure S17 The selection flowchart of behavioral risk factors for EOPC.

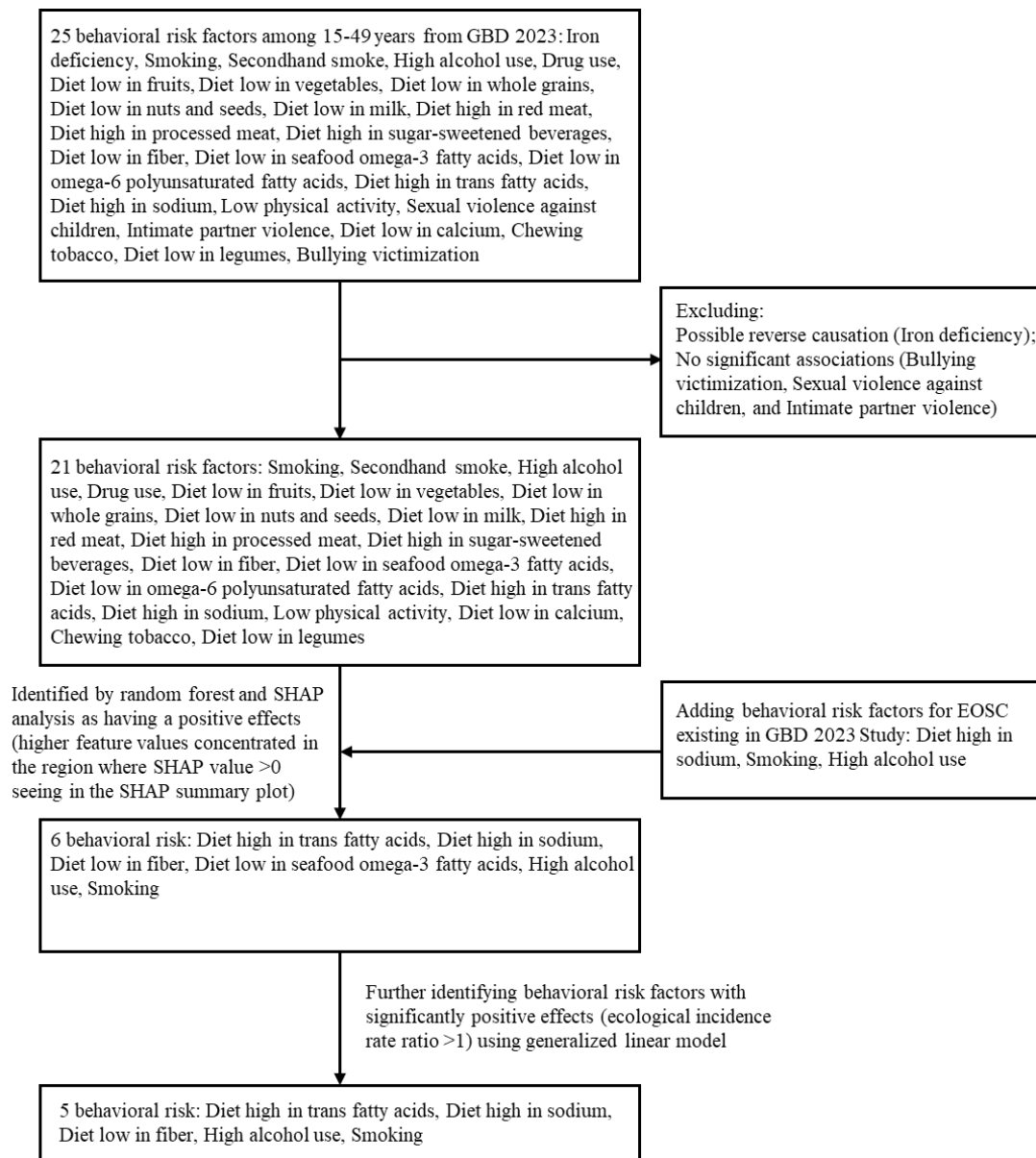


Figure S18 The selection flowchart of behavioral risk factors for EOSC.

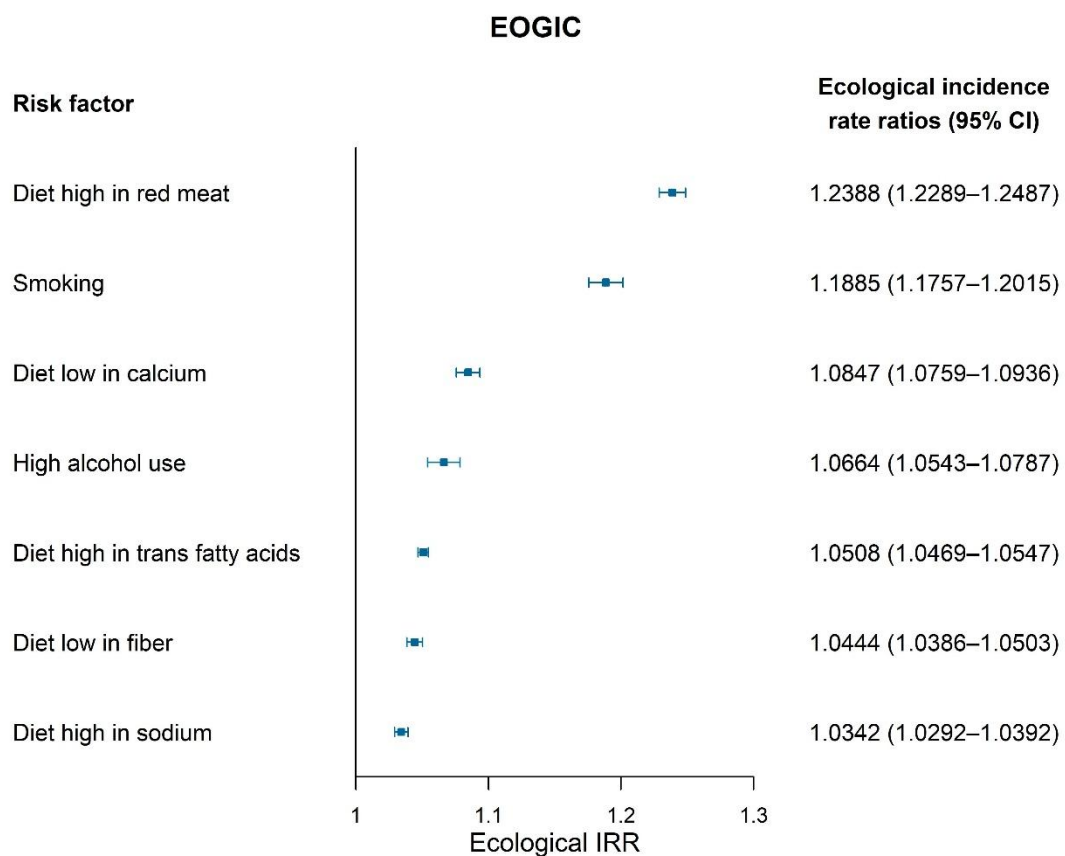


Figure S19 Ecological incidence rate ratios and 95% CIs of behavioral risk factors related to the age-standardized incidence rates of total early-onset gastrointestinal cancer.

CI: confidence interval; EOGIC: early-onset gastrointestinal cancer.

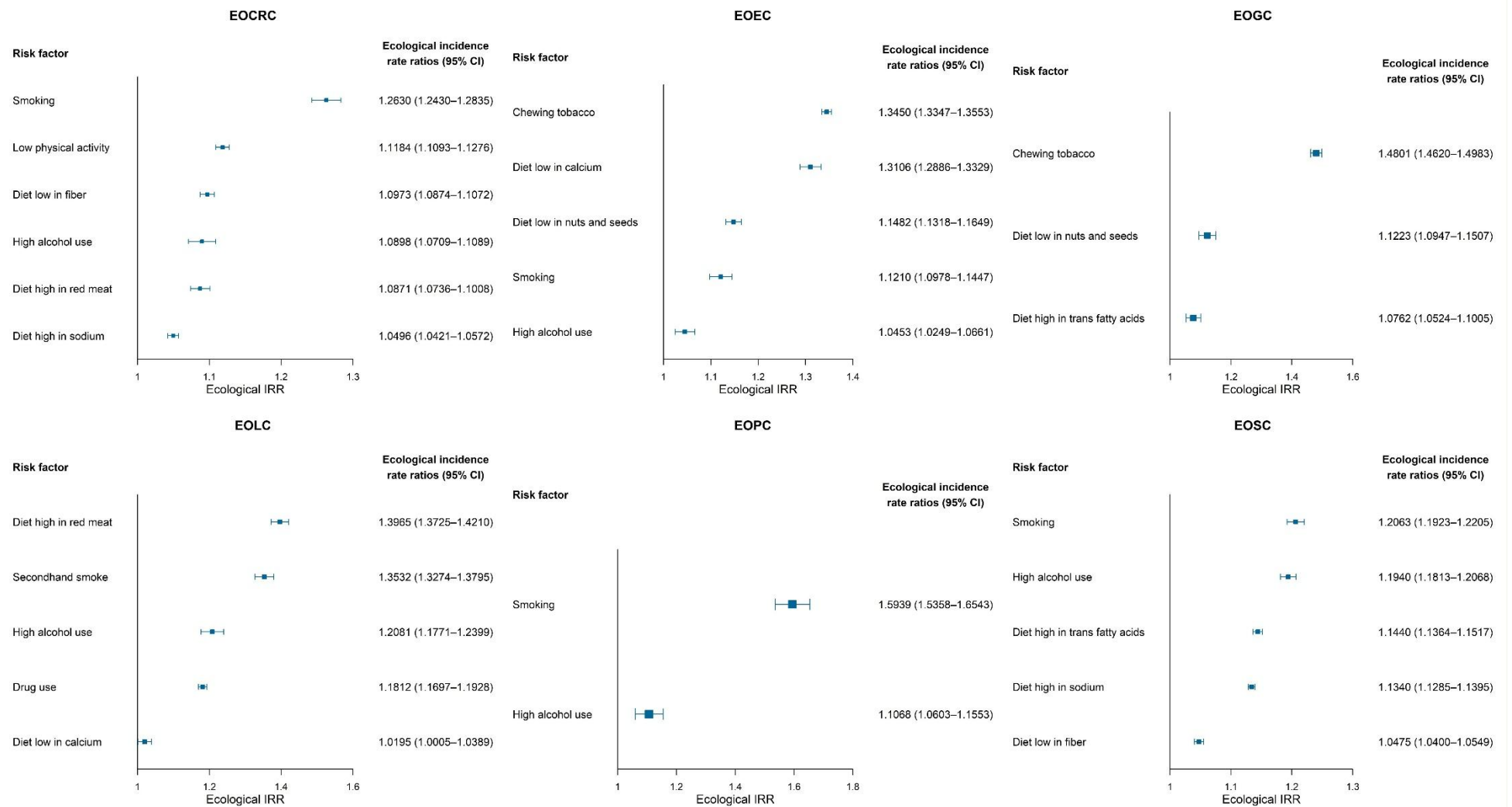


Figure S20 Ecological incidence rate ratios and 95% CIs of behavioral risk factors related to the age-standardized incidence rates of six types of early-onset gastrointestinal cancers.

CI: confidence interval; EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer.

Table S1 Adherence to JoGH’s GRABDROP guidelines items.

JoGH guideline items
1. Please list all papers published by each co-author in previous 3 years that were based on secondary analysis of a big data repository
[1] Yan W, Liu M, Jing W, Kang L , Zhang N, Sun H, He J , Chen Z, Liu J, Liang W, Dong J . Disparities in the incidence, mortality and disability-adjusted life years of 33 early-onset cancer groups globally, 2012-2021: a systematic analysis. <i>Exp Hematol Oncol</i> . 2025 Mar 17;14(1):38. [2] Chen W, Du M, Liu M, Liu J . Co-occurrence patterns and related risk factors of dementia and Parkinson's disease among older adults across 204 countries and territories: a spatial correspondence and systematic analysis. <i>BMC Med</i> . 2026 Jan 15. [3] Li C, Qi J, Yin P, Yu X, Sun H , Zhou M, Liang W . The burden of type 2 diabetes attributable to air pollution across China and its provinces, 1990-2021: an analysis for the Global Burden of Disease Study 2021. <i>Lancet Reg Health West Pac</i> . 2024;53:101246. [4] Kang L, Yan W, Jing W, He J , Zhang N, Liu M, Liang W . Temporal trends, disease burden and attributable risk factors of stomach and colorectal cancers among 31 countries and territories in Western Pacific region, 2000-2021. <i>Chin J Cancer Res</i> . 2025;37(2):187-199.
2. Please explain the key elements of your study design and the use of the available datasets that make your study an original scientific contribution
Key elements of study design: We conducted a global ecological study to characterize the incidence early-onset gastrointestinal cancers (EOGIC) and their behavioral risk factors. The design combined (1) a contemporary cross-sectional assessment of EOGIC incidence across countries and subtypes, (2) a registry-based longitudinal trend analysis in quality-assured populations over a decade, and (3) an integrated risk-factor attribution framework. Methodologically, we used a two-stage analytic strategy to strengthen interpretability and robustness: machine learning (random forest) with SHAP values to screen and prioritize influential behavioral exposures in a high-dimensional setting, followed by generalized linear modeling (Poisson regression with log link) to estimate adjusted relative risks and quantify independent effects. We then translated these associations into population-relevant impact by computing population-attributable fractions (PAFs), enabling direct interpretation of which modifiable behaviors account for the largest share of EOGIC incidence and providing actionable prevention targets. Original scientific contribution through use of datasets: Our study is original because it brings together complementary public data sources to address different but related epidemiological questions on EOGIC. Specifically, GLOBOCAN 2022 was used to describe the contemporary global incidence patterns in 2022, CI5plus was used to assess registry-based temporal trends in selected countries/populations with eligible annual data, and

GBD 2023 SEVs were used for exploratory country-level ecological analyses of behavioral exposures. These components were interpreted as complementary rather than directly interchangeable, and their integration was used to triangulate evidence across incidence patterns, selected historical trends, and ecological exposure correlations.

3. Please list all publications that addressed similar research questions in the same dataset and indicate where you cited them in your paper

[1] Pan H, Tang Y, Zhu H, Sun Y, Chi P, Huang Y. Global burden, trends, and risk factors of early-onset and late-onset colorectal cancer from 1990 to 2021, with projections to 2040: a population-based study. *BMC Gastroenterol* 2025; 25(1): 486. (cited as Ref 11)

[2] Danpanichkul P, Suparan K, Auttapracha T, Tothananarungroj P, Kongarin S, Rakwong K, et al. Early-Onset Gastrointestinal Cancers and Metabolic Risk Factors: Global Trends From the Global Burden of Disease Study 2021. *Mayo Clin Proc* 2025; 100(7): 1159-71. (cited as Ref 7)

[3] Meng Y, Tan Z, Zhen J, Xiao D, Cai L, Dong W, et al. Global, regional, and national burden of early-onset colorectal cancer from 1990 to 2021: a systematic analysis based on the global burden of disease study 2021. *BMC Med* 2025; 23(1): 34. (cited as Ref 19)

[4] Junhai Z, Yang M, Zongbiao T, Wenxuan Y, Tiange L, Yanrui W, et al. Global, regional, and national burden of very early-onset colorectal cancer and its risk factors from 1990 to 2019: A systematic analysis for the global burden of disease study 2019. *Neoplasia* 2025; 60: 101114. (cited as Ref 20)

4. Please explain how you addressed multiple testing through an appropriately rigorous statistical threshold and indicate this in the methods section

As this study did not involve repeated hypothesis testing across multiple comparisons, issues of multiple testing were not considered applicable.

5. Please declare to what extent have AI chatbots been used in developing your paper and to which parts of the paper did they contribute

AI chatbots did not contribute to study design, data analysis, interpretation, conclusions, or paper writing. All scientific content was conceived, executed, and validated by the authors.

Table S2 Guidelines for Accurate and Transparent Health Estimates Reporting

Item #	Checklist item	Reported on page #
Objectives and funding		
1	Define the indicator(s), populations (including age, sex, and geographic entities), and time period(s) for which estimates were made.	Page 5-6
2	List the funding sources for the work.	Page 17
Data Inputs		
<i>For all data inputs from multiple sources that are synthesized as part of the study:</i>		
3	Describe how the data were identified and how the data were accessed.	Page 6-7
4	Specify the inclusion and exclusion criteria. Identify all ad-hoc exclusions.	Page 6-8
5	Provide information on all included data sources and their main characteristics. For each data source used, report reference information or contact name/institution, population represented, data collection method, year(s) of data collection, sex and age range, diagnostic criteria or measurement method, and sample size, as relevant.	Page 6-7
6	Identify and describe any categories of input data that have potentially important biases (e.g., based on characteristics listed in item 5).	Page 9
<i>For data inputs that contribute to the analysis but were not synthesized as part of the study:</i>		
7	Describe and give sources for any other data inputs.	Page 6-7
<i>For all data inputs:</i>		
8	Provide all data inputs in a file format from which data can be efficiently extracted (e.g., a spreadsheet rather than a PDF), including all relevant meta-data listed in item 5. For any data inputs that cannot be shared because of ethical or legal reasons, such as third-party ownership, provide a contact name or the name of the institution that retains the right to the data.	Page 17
Data analysis		
9	Provide a conceptual overview of the data analysis method. A diagram may be helpful.	Figure S10-S16
10	Provide a detailed description of all steps of the analysis, including mathematical formulae. This description should cover, as relevant, data cleaning, data pre-processing, data adjustments and weighting of data sources, and mathematical or statistical model(s).	Page 6-7, Table S3
11	Describe how candidate models were evaluated and how the final model(s) were selected.	Page 8-9
12	Provide the results of an evaluation of model performance, if done, as well as the results of any relevant sensitivity analysis.	Page 9

13	Describe methods for calculating uncertainty of the estimates. State which sources of uncertainty were, and were not, accounted for in the uncertainty analysis.	Page 8-9
14	State how analytic or statistical source code used to generate estimates can be accessed.	Page 8-9
Results and Discussion		
15	Provide published estimates in a file format from which data can be efficiently extracted.	Page 9-10
16	Report a quantitative measure of the uncertainty of the estimates (e.g. uncertainty intervals).	Page 10-11
17	Interpret results in light of existing evidence. If updating a previous set of estimates, describe the reasons for changes in estimates.	Page 12-14
18	Discuss limitations of the estimates. Include a discussion of any modelling assumptions or data limitations that affect interpretation of the estimates.	Page 15

Table S3 Roles, coverage, and harmonization of the three public data sources

Data source	Analytic purpose	Year(s) used	Geographic coverage	Key variables extracted	Notes on comparability / linkage
GLOBOCAN 2022	Cross-sectional incidence description	2002	185 countries/territories	Incident cases, ASIRs	Model-based estimates, used only for contemporary incidence patterns
CI5plus	Trend analysis	Mainly 2008-2017	Selected eligible registry populations/countries (46 countries)	annual ASIRs	Registry-based trend analysis, not globally representative
GBD 2023	Investigating potential influence factors for the incidence rates of EOGIC	2022	204 countries/territories	SEVs for behavioral risks in ages 15–49.	Risk-weighted exposure summaries, not raw prevalence

Table S4 Incident cases and age-standardized incidence rates of early-onset gastrointestinal cancers among males in 2022.

		EOGIC		EOCRC		EOEC		EOGC		EOLC		EOPC		EOSC	
		cases (% of all- age cases)	ASIR	cases (% of all-age cases)	ASIR	cases (% of all-age cases)	ASIR	cases (% of all-age cases)	ASIR	cases (% of all- age cases)	ASIR	cases (% of all-age cases)	ASIR	cases (% of all-age cases)	ASIR
World		277329 (9.32)	13.60	98587 (9.22)	4.80	30316 (8.30)	1.50	3682 (8.46)	0.18	83087 (13.83)	4.00	17644 (6.54)	0.87	44013 (7.01)	2.20
Africa	Eastern Africa	9720 (28.22)	10.70	2887 (30.05)	3.10	2224 (22.65)	2.70	71 (16.25)	0.09	3035 (40.89)	3.20	394 (19.89)	0.46	1109 (21.43)	1.20
	Middle Africa	4210 (34.75)	12.20	935 (33.73)	2.60	278 (16.59)	0.91	11 (16.67)	0.03	2239 (44.49)	6.30	268 (32.96)	0.88	479 (27.28)	1.50
	Northern Africa	8009 (17.99)	13.30	2782 (23.13)	4.50	280 (15.80)	0.44	69 (6.82)	0.11	3183 (15.80)	5.50	595 (14.65)	0.99	1100 (19.95)	1.80
	Southern Africa	1870 (18.03)	10.40	852 (21.01)	4.70	251 (11.96)	1.50	15 (20.83)	0.08	399 (25.32)	2.20	150 (11.10)	0.85	203 (16.68)	1.10
	Western Africa	9666 (35.57)	11.80	2230 (28.86)	2.70	323 (23.77)	0.40	41 (18.30)	0.05	5636 (48.04)	6.80	414 (19.99)	0.55	1022 (25.15)	1.30
America	Caribbean	1197 (9.12)	11.10	498 (8.80)	4.60	100 (7.58)	0.95	9 (10.47)	0.08	205 (10.36)	1.90	122 (7.84)	1.10	263 (10.41)	2.50
	Central America	3643 (12.00)	8.00	1804 (17.13)	3.90	126 (8.83)	0.28	24 (6.52)	0.05	363 (5.66)	0.82	350 (9.62)	0.76	976 (12.24)	2.10
	Northern America	16621 (8.16)	17.70	11897 (12.23)	12.70	751 (4.41)	0.81	88 (5.06)	0.09	894 (2.61)	0.95	1503 (4.27)	1.60	1488 (8.21)	1.60
	South America	11860 (8.71)	10.20	5670 (10.00)	4.90	1195 (9.37)	1.00	170 (6.71)	0.14	963 (6.62)	0.82	1090 (7.25)	0.92	2772 (8.00)	2.40
Asia	Eastern Asia	98153 (7.12)	20.60	28402 (6.94)	6.00	4893 (2.62)	1.00	693 (3.61)	0.14	44167 (14.09)	9.20	5055 (5.26)	1.10	14943 (4.22)	3.20
	South Central Asia	49825 (18.13)	9.10	14416 (21.89)	2.60	15362 (21.21)	2.80	2137 (19.92)	0.39	5326 (13.34)	0.98	2137 (14.74)	0.39	10447 (14.62)	1.90
	South-eastern Asia	27808 (14.90)	14.90	8830 (13.94)	4.80	1895 (15.60)	1.00	177 (7.91)	0.09	12851 (17.03)	6.80	1185 (12.28)	0.63	2870 (12.08)	1.60
	Western Asia	7896 (14.04)	9.30	4039 (17.12)	4.70	290 (12.60)	0.33	66 (9.68)	0.08	766 (10.73)	0.92	915 (10.76)	1.10	1820 (12.97)	2.20
Europe	Eastern Europe	11252 (6.10)	13.30	4699 (5.06)	5.60	1249 (9.12)	1.50	59 (4.10)	0.07	1237 (8.20)	1.50	1730 (7.57)	2.00	2278 (5.93)	2.70
	Northern Europe	2861 (3.72)	10.40	1668 (3.86)	6.10	256 (2.93)	0.92	12 (2.14)	0.04	259 (3.42)	0.96	321 (3.24)	1.20	345 (4.97)	1.20
	Southern Europe	5266 (4.06)	11.70	2739 (3.77)	6.20	342 (6.85)	0.74	18 (1.78)	0.04	850 (5.10)	1.90	598 (3.67)	1.30	719 (3.94)	1.60
	Western Europe	5673 (3.69)	11.60	3117 (3.88)	6.40	419 (3.20)	0.84	15 (1.55)	0.03	430 (2.28)	0.88	717 (3.00)	1.50	975 (5.80)	2.00
Oceania	Australia-New Zealand	1478 (7.43)	18.60	1053 (9.40)	13.30	62 (3.99)	0.77	7 (4.43)	0.09	135 (5.01)	1.70	84 (3.74)	1.00	137 (6.72)	1.70
	Melanesia	293 (16.97)	10.90	62 (12.25)	2.40	20 (12.42)	0.77	0 (0)	0	132 (22.34)	4.90	15 (14.85)	0.59	64 (19.39)	2.30

	Micronesia	15 (8.47)	12.30	3 (5.66)	2.60	0 (0)	0	0 (-)	0	12 (15.79)	9.70	0 (0)	0	0 (0)	0
	Polynesia	13 (6.53)	7.90	4 (5.41)	2.40	0 (0)	0	0 (0)	0	5 (12.2)	3.00	1 (4.00)	0.61	3 (8.33)	1.80
HDI	Very high	62081 (5.35)	13.70	33433 (6.30)	7.40	3538 (4.33)	0.77	435 (3.05)	0.09	8517 (5.20)	1.90	6583 (4.43)	1.40	9575 (4.33)	2.10
	High	130958 (9.26)	16.70	41525 (9.59)	5.30	7581 (3.90)	0.97	910 (5.55)	0.11	53885 (15.34)	6.80	7348 (7.49)	0.93	19709 (6.14)	2.50
	Medium	59820 (18.82)	10.20	15896 (19.47)	2.70	15667 (21.36)	2.70	2123 (18.56)	0.36	12207 (19.63)	2.00	2680 (15.09)	0.46	11247 (15.74)	1.90
	Low	24396 (29.41)	10.20	7708 (32.46)	3.10	3526 (22.77)	1.60	214 (14.79)	0.10	8453 (36.49)	3.50	1027 (20.57)	0.45	3468 (24.56)	1.50

ASIR: age-standardized incidence rate (per 100,000 persons); EOGIC: early-onset gastrointestinal cancer; EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer; HDI: human development index.

Table S5 Incident cases and age-standardized incidence rates of early-onset gastrointestinal cancers among females in 2022.

		EOGIC		EOCRC		EOEC		EOGC		EOLC		EOPC		EOSC	
		cases (% of all- age cases)	ASIR	cases (% of all-age cases)	ASIR	cases (% of all-age cases)	ASIR	cases (% of all-age cases)	ASIR	cases (% of all- age cases)	ASIR	cases (% of all-age cases)	ASIR	cases (% of all-age cases)	ASIR
World		188255 (9.76)	9.40	88253 (10.3)	4.40	14933 (10.24)	0.74	9851 (12.48)	0.49	25671 (9.67)	1.30	12004 (4.98)	0.6	37543 (11.00)	1.90
Africa	Eastern Africa	8170 (26.22)	9.00	3150 (32.27)	3.40	1841 (22.68)	2.10	117 (13.64)	0.14	1619 (30.19)	1.70	318 (16.04)	0.35	1125 (22.15)	1.30
	Middle Africa	2485 (28.94)	7.20	853 (32.50)	2.40	207 (22.00)	0.65	13 (12.62)	0.04	945 (36.56)	2.80	102 (16.48)	0.30	365 (21.30)	1.10
	Northern Africa	7112 (20.92)	11.30	3167 (27.47)	5.00	295 (20.22)	0.46	256 (12.34)	0.41	1947 (16.41)	3.10	361 (13.24)	0.58	1086 (25.01)	1.7
	Southern Africa	1672 (18.55)	9.10	843 (23.08)	4.50	141 (9.26)	0.81	36 (12.24)	0.20	285 (22.75)	1.6	219 (14.70)	1.20	148 (18.43)	0.80
	Western Africa	5667 (27.37)	7.00	1956 (29.32)	2.40	196 (16.32)	0.23	134 (36.02)	0.17	2003 (29.14)	2.40	567 (29.89)	0.78	811 (21.98)	1.00
America	Caribbean	1048 (8.97)	9.40	508 (8.02)	4.60	48 (10.93)	0.44	28 (11.24)	0.25	169 (10.46)	1.50	98 (7.01)	0.88	197 (11.92)	1.70
	Central America	3793 (12.89)	7.60	1775 (17.27)	3.50	53 (9.96)	0.11	152 (11.00)	0.31	422 (6.49)	0.85	309 (8.09)	0.62	1082 (15.65)	2.20
	Northern America	14930 (9.78)	15.90	11167 (12.88)	11.90	208 (4.29)	0.22	175 (5.01)	0.19	521 (3.66)	0.57	1406 (4.41)	1.50	1453 (12.57)	1.50
	South America	11322 (9.99)	9.20	6392 (11.50)	5.20	245 (6.28)	0.20	450 (7.74)	0.37	847 (7.24)	0.69	840 (5.39)	0.69	2548 (12.32)	2.10
Asia	Eastern Asia	49524 (6.64)	11.10	23035 (7.93)	5.10	1455 (2.36)	0.32	1029 (3.81)	0.22	8635 (7.24)	1.90	2991 (3.69)	0.68	12379 (7.43)	2.80
	South Central Asia	40436 (22.62)	7.70	10566 (23.67)	2.00	9178 (21.58)	1.80	6963 (28.38)	1.30	3630 (18.38)	0.69	1353 (15.09)	0.26	8746 (22.80)	1.60
	South-eastern Asia	14622 (13.81)	7.80	7740 (15.63)	4.10	235 (7.94)	0.13	195 (7.74)	0.10	3113 (11.05)	1.70	731 (9.50)	0.39	2608 (17.34)	1.40
	Western Asia	6135 (14.81)	8.50	3289 (16.81)	4.60	350 (16.33)	0.50	117 (9.63)	0.17	502 (11.82)	0.69	494 (8.14)	0.68	1383 (16.88)	1.90
Europe	Eastern Europe	8332 (5.41)	9.60	4683 (5.41)	5.40	214 (6.27)	0.24	83 (2.35)	0.09	457 (4.74)	0.55	818 (3.58)	0.96	2077 (7.43)	2.40
	Northern Europe	2826 (4.56)	10.40	2066 (5.48)	7.60	87 (2.22)	0.31	36 (2.48)	0.13	130 (2.73)	0.49	241 (2.04)	0.89	266 (6.51)	0.97
	Southern Europe	3941 (4.13)	9.00	2625 (4.77)	6.00	58 (4.01)	0.13	24 (1.34)	0.05	163 (2.08)	0.38	486 (2.91)	1.10	585 (4.65)	1.40
	Western Europe	4661 (3.92)	9.70	3159 (4.52)	6.60	108 (2.56)	0.22	26 (1.36)	0.05	193 (2.28)	0.40	584 (2.44)	1.20	591 (5.61)	1.20
Oceania	Australia-New Zealand	1477 (9.49)	18.80	1232 (12.37)	15.80	12 (2.01)	0.15	11 (3.86)	0.13	47 (4.61)	0.59	83 (3.45)	1.00	92 (7.10)	1.10
	Melanesia	87 (7.84)	3.50	38 (10.58)	1.50	2 (2.27)	0.09	6 (13.33)	0.22	38 (10.64)	1.60	3 (5.88)	0.11	0 (0)	0

	Micronesia	9 (10.47)	7.10	6 (13.33)	5.00	0 (-)	0	0 (-)	0	3 (21.43)	2.20	0 (0)	0	0 (0)	0
	Polynesia	6 (5.71)	3.70	3 (6.25)	1.80	0 (0)	0	0 (0)	0	2 (16.67)	1.20	0 (0)	0	1 (3.70)	0.61
HDI	Very high	51478 (6.03)	11.80	33591 (7.40)	7.70	1135 (4.40)	0.25	770 (3.20)	0.17	2919 (3.86)	0.68	4601 (3.17)	1.10	8462 (6.52)	1.90
	High	74210 (9.32)	9.70	35553 (11.08)	4.60	2223 (3.30)	0.29	1583 (6.09)	0.21	13404 (9.29)	1.80	4729 (5.99)	0.62	16718 (10.54)	2.20
	Medium	43175 (20.55)	7.50	12115 (19.91)	2.10	7851 (19.83)	1.40	7014 (27.32)	1.20	5144 (17.3)	0.90	1635 (12.50)	0.29	9416 (22.86)	1.60
	Low	19334 (28.08)	8.10	6963 (32.93)	2.90	3721 (28.4)	1.60	484 (15.08)	0.22	4192 (26.75)	1.70	1038 (25.09)	0.47	2936 (25.32)	1.20

ASIR: age-standardized incidence rate (per 100,000 persons); EOGIC: early-onset gastrointestinal cancer; EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer; HDI: human development index.

Table S6 Incident cases and age-standardized incidence rates of early-onset gastrointestinal cancers by countries in 2022.

	EOGIC		EOCRC		EOEC		EOGC		EOLC		EOPC		EOSC	
	Incident	ASIR	Incident	ASIR	Incident	ASIR	Incident	ASIR	Incident	ASIR	Incident	ASIR	Incident	ASIR
	cases		cases		cases		cases		cases		cases		cases	
Afghanistan	1215	7.9	377	2.3	222	1.4	24	0.17	186	1.2	85	0.54	321	2.3
Albania	131	9.6	58	4.2	4	0.30	3	0.23	13	0.95	12	0.90	41	3
Algeria	2291	9.5	1415	5.8	56	0.22	118	0.50	78	0.32	116	0.48	508	2.1
Angola	1154	9.3	329	2.5	115	1.1	8	0.07	415	3.2	124	1.1	163	1.4
Argentina	2520	10.6	1544	6.5	95	0.39	89	0.37	153	0.64	286	1.2	353	1.5
Armenia	123	8.1	27	1.8	2	0.14	1	0.06	30	2.0	28	1.8	35	2.3
Australia	2632	19.6	2060	15.4	64	0.46	16	0.11	158	1.2	145	1.1	189	1.4
Austria	523	11.1	338	7.2	27	0.56	1	0.02	26	0.56	63	1.3	68	1.4
Azerbaijan	614	11.3	266	4.8	70	1.3	12	0.20	61	1.1	43	0.74	162	3.2
Bahamas	16	7.1	11	4.9	1	0.43	0	0.00	1	0.43	1	0.43	2	0.88
Bahrain	47	3.7	26	2.1	1	0.05	2	0.21	5	0.34	4	0.33	9	0.63
Bangladesh	14644	15.9	1896	2.0	7172	7.9	2561	2.7	663	0.72	313	0.34	2039	2.2
Barbados	14	9.1	11	7.2	0	0.00	0	0.00	1	0.62	0	0.00	2	1.3
Belarus	729	13.8	323	6.1	57	1.1	5	0.09	49	1.0	86	1.6	209	3.9
Belgium	650	10.9	404	6.8	37	0.60	2	0.03	41	0.68	80	1.4	86	1.4
Belize	8	3.9	1	0.42	0	0.00	0	0.00	2	0.91	1	0.57	4	2
Benin	527	10.3	131	2.5	30	0.57	14	0.25	248	4.8	22	0.41	82	1.7
Bhutan	37	9.2	4	0.98	9	2.3	2	0.51	7	1.7	1	0.29	14	3.5
Bolivia	388	6.9	95	1.7	10	0.18	40	0.69	83	1.5	15	0.25	145	2.6
(Plurinational														

State of)														
Bosnia	245	13.5	133	7.4	6	0.33	3	0.16	19	1.0	35	1.9	49	2.7
Herzegovina														
Botswana	68	5.5	37	2.9	16	1.5	0	0.00	7	0.56	3	0.21	5	0.41
Brazil	12853	10.4	6993	5.7	1187	0.97	191	0.15	1091	0.89	991	0.80	2400	2
Brunei Darussalam	38	13.1	27	9.3	0	0.00	0	0.00	4	1.4	0	0.00	7	2.4
Bulgaria	419	10.3	197	4.8	21	0.50	1	0.02	41	0.97	60	1.4	99	2.5
Burkina Faso	1480	18.6	246	2.8	61	0.62	10	0.09	813	10.1	299	4.5	51	0.59
Burundi	367	8.6	99	2.3	84	2.2	2	0.05	113	2.4	16	0.36	53	1.3
Cambodia	1195	15.4	321	4.1	16	0.28	9	0.12	707	9.1	48	0.54	94	1.2
Cameroon	1017	9.2	304	2.8	33	0.35	4	0.04	493	4.2	47	0.49	136	1.3
Canada	2777	13.8	2027	10.1	82	0.41	25	0.12	182	0.92	224	1.1	237	1.2
Cape Verde	14	4.4	6	1.9	3	1.0	0	0.00	2	0.62	1	0.31	2	0.62
Central African Republic	154	8.7	56	3.0	8	0.46	0	0.00	68	3.8	4	0.28	18	1.1
Chad	1151	20.0	134	2.1	68	1.3	0	0.00	759	13.5	54	0.97	136	2.2
Chile	885	8.3	451	4.3	13	0.12	83	0.77	36	0.33	80	0.74	222	2.1
China	130030	16.0	43361	5.4	5841	0.71	1412	0.17	49936	6.1	6665	0.82	22815	2.8
Colombia	2701	9.8	1296	4.7	42	0.15	46	0.17	135	0.48	189	0.68	993	3.6
Comoros	31	7.9	0	0.00	13	3.5	0	0.00	17	4.1	1	0.33	0	0
Congo, Democratic Republic of	2729	8.1	839	2.4	251	0.81	9	0.03	1186	3.4	114	0.36	330	1
Congo, Republic of	226	9.2	53	2.2	2	0.09	0	0.00	134	5.3	7	0.30	30	1.3

Costa Rica	207	7.3	100	3.5	1	0.04	1	0.04	19	0.66	15	0.52	71	2.5
Côte d'Ivoire	1175	10.8	324	3.0	27	0.25	42	0.41	586	5.2	56	0.55	140	1.4
Croatia	264	12.0	179	8.2	12	0.54	2	0.09	11	0.49	14	0.62	46	2.1
Cuba	426	7.4	191	3.4	66	1.1	6	0.11	53	0.93	50	0.84	60	1
Cyprus	58	8.2	36	5.1	0	0.00	0	0.00	3	0.44	9	1.3	10	1.4
Czechia	667	10.2	432	6.7	48	0.66	7	0.09	28	0.45	87	1.3	65	0.95
Denmark	316	11.0	225	7.8	9	0.30	1	0.03	17	0.62	28	0.95	36	1.2
Djibouti	38	6.9	21	3.7	3	0.59	0	0.00	7	1.3	1	0.21	6	1.1
Dominican Republic	626	11.3	259	4.7	24	0.43	10	0.17	128	2.3	103	1.9	102	1.8
Ecuador	727	7.9	311	3.4	8	0.09	18	0.20	47	0.49	62	0.67	281	3
Egypt	8812	17.7	2291	4.4	257	0.48	100	0.19	4603	9.5	578	1.2	983	1.9
El Salvador	265	8.3	125	3.9	7	0.22	9	0.28	38	1.2	19	0.57	67	2.2
Equatorial Guinea	94	13.8	27	3.9	3	0.53	1	0.11	48	6.7	5	1.0	10	1.6
Eritrea	114	7.9	59	3.9	12	0.86	0	0.00	20	1.5	5	0.39	18	1.3
Estonia	70	9.3	37	4.9	4	0.53	0	0.00	4	0.52	3	0.39	22	2.9
Eswatini	35	6.9	16	3.1	3	0.67	0	0.00	13	2.5	2	0.41	1	0.25
Ethiopia	4437	9.3	2448	5.1	279	0.64	70	0.16	595	1.3	231	0.50	814	1.7
Fiji	38	8.1	14	3.0	2	0.44	1	0.20	14	3.0	2	0.44	5	1
Finland	238	8.8	168	6.2	6	0.22	2	0.07	11	0.41	23	0.86	28	1.1
France (metropolitan)	4309	13.2	2682	8.2	232	0.69	19	0.06	268	0.81	567	1.7	541	1.7
France, Guadeloupe	24	13.0	13	7.2	2	0.97	0	0.00	1	0.49	3	1.6	5	2.7
France, La	47	10.2	21	4.6	6	1.3	0	0.00	4	0.85	5	1.1	11	2.4

Réunion														
France, Martinique	16	9.5	11	6.7	0	0.00	0	0.00	1	0.55	1	0.55	3	1.8
French Guyana	9	5.8	3	2.0	0	0.00	0	0.00	2	1.3	2	1.3	2	1.3
French Polynesia	10	6.2	2	1.2	0	0.00	0	0.00	5	3.1	1	0.62	2	1.2
Gabon	158	14.1	45	4.0	5	0.46	2	0.18	76	6.6	14	1.4	16	1.5
Gaza Strip and West Bank	199	9.0	116	5.3	6	0.27	3	0.15	16	0.71	14	0.66	44	1.9
Georgia	147	7.1	41	2.0	5	0.23	1	0.05	44	2.1	16	0.78	40	1.9
Germany	3419	8.5	1915	4.8	152	0.37	8	0.02	217	0.55	434	1.1	693	1.7
Ghana	2677	17.9	305	2.1	104	0.80	33	0.26	1981	12.9	52	0.40	202	1.5
Greece	493	8.1	274	4.5	17	0.27	2	0.03	43	0.71	78	1.3	79	1.3
Guam	8	9.8	3	3.7	0	0.00	0	0.00	5	6.1	0	0.00	0	0
Guatemala	588	7.1	139	1.6	16	0.18	3	0.04	145	1.9	41	0.51	244	2.9
Guinea	835	18.2	74	1.4	15	0.30	6	0.11	618	13.6	20	0.47	102	2.3
Guinea-Bissau	96	11.8	15	1.8	0	0.00	0	0.00	67	8.1	1	0.17	13	1.7
Guyana	27	7.1	8	2.0	1	0.26	1	0.28	6	1.5	2	0.55	9	2.4
Haiti	677	12.2	210	3.8	39	0.72	11	0.22	156	2.7	24	0.39	237	4.4
Honduras	381	7.7	104	2.1	16	0.30	26	0.54	82	1.6	30	0.64	123	2.5
Hungary	725	11.8	502	8.3	34	0.52	4	0.07	23	0.35	83	1.3	79	1.3
Iceland	16	8.9	14	7.8	0	0.00	0	0.00	0	0.00	2	1.1	0	0
India	54896	7.3	14849	2.0	13768	1.9	5723	0.76	5766	0.77	2140	0.29	12650	1.7
Indonesia	12480	8.0	6426	4.1	146	0.09	52	0.03	4574	2.9	682	0.43	600	0.38
Iran, Islamic Republic of	5399	10.4	2826	5.3	340	0.65	68	0.13	856	1.6	304	0.59	1005	2.1
Iraq	1408	7.5	723	3.8	67	0.35	23	0.13	115	0.61	127	0.70	353	1.9

Ireland	304	10.2	192	6.5	21	0.69	1	0.03	26	0.92	24	0.79	40	1.3
Israel	543	12.5	390	9.0	9	0.21	2	0.05	25	0.58	47	1.1	70	1.6
Italy	3379	10.1	2136	6.4	100	0.29	15	0.04	389	1.1	383	1.1	356	1.1
Jamaica	147	9.5	89	5.7	5	0.32	8	0.49	11	0.71	11	0.69	23	1.5
Japan	8175	12.1	4905	7.2	296	0.42	163	0.23	565	0.77	801	1.1	1445	2.4
Jordan	590	11.6	345	6.8	12	0.24	10	0.21	38	0.75	63	1.3	122	2.4
Kazakhstan	785	8.1	286	2.9	45	0.45	6	0.06	88	0.90	100	1.0	260	2.8
Kenya	2025	8.5	722	3.0	492	2.2	62	0.27	303	1.2	107	0.44	339	1.4
Korea, Democratic People Republic of	2055	14.2	608	4.2	116	0.78	48	0.32	754	5.2	114	0.78	415	2.9
Korea, Republic of	6846	21.7	2516	8.0	77	0.24	97	0.30	1232	3.8	445	1.5	2479	7.8
Kuwait	133	3.7	86	2.4	3	0.08	3	0.08	12	0.31	12	0.31	17	0.47
Kyrgyzstan	250	8.1	58	1.8	7	0.20	5	0.17	33	1.1	22	0.66	125	4.2
Lao People's Democratic Republic	692	19.4	177	4.9	62	1.8	10	0.28	275	7.8	21	0.57	147	4.1
Latvia	94	9.2	32	3.1	7	0.69	0	0.00	7	0.68	13	1.3	35	3.4
Lebanon	293	8.2	183	5.1	6	0.17	3	0.09	22	0.61	33	0.93	46	1.3
Lesotho	53	5.5	20	2.0	14	1.5	0	0.00	14	1.3	2	0.20	3	0.37
Liberia	312	14.7	46	2.1	6	0.29	4	0.19	209	9.8	8	0.40	39	1.9
Libya	387	8.8	249	5.7	3	0.06	25	0.55	29	0.67	38	0.88	43	0.98
Lithuania	157	11.4	49	3.5	17	1.2	1	0.07	20	1.5	25	1.8	45	3.3
Luxembourg	27	7.0	16	4.1	1	0.26	0	0.00	1	0.26	2	0.52	7	1.9
Madagascar	1083	8.7	264	2.1	169	1.5	2	0.01	517	4.0	43	0.37	88	0.77
Malawi	1324	17.2	223	2.8	781	10.4	2	0.03	213	2.6	22	0.30	83	1.1

Malaysia	2066	11.3	1229	6.8	40	0.23	14	0.08	421	2.3	123	0.66	239	1.3
Maldives	24	7.0	15	4.5	0	0.00	0	0.00	8	2.3	1	0.19	0	0
Mali	1288	17.2	366	4.8	103	1.4	6	0.08	389	5.1	60	0.84	364	5.1
Malta	25	10.0	17	6.8	0	0.00	0	0.00	1	0.38	4	1.6	3	1.2
Mauritania	245	11.7	59	2.8	12	0.58	5	0.23	121	5.7	10	0.49	38	1.9
Mauritius	60	8.2	30	4.1	2	0.27	0	0.00	8	1.1	10	1.4	10	1.4
Mexico	5543	7.9	2936	4.2	127	0.18	122	0.18	435	0.62	525	0.74	1398	2
Mongolia	571	32.2	47	2.5	18	1.0	2	0.11	315	18.3	21	1.1	168	9.2
Montenegro	19	5.5	13	3.8	1	0.29	0	0.00	1	0.29	3	0.88	1	0.29
Morocco	1709	8.7	958	4.9	57	0.28	61	0.31	83	0.43	122	0.63	428	2.2
Mozambique	1693	12.9	202	1.5	511	4.4	0	0.00	919	6.6	34	0.28	27	0.21
Myanmar	4227	14.1	1015	3.4	811	2.7	101	0.33	1102	3.6	119	0.40	1079	3.6
Namibia	87	7.6	45	3.9	4	0.41	1	0.11	22	1.9	3	0.30	12	1
Nepal	995	6.9	304	2.0	33	0.25	254	1.8	91	0.63	52	0.38	261	1.8
New Caledonia	13	7.8	4	2.4	0	0.00	0	0.00	4	2.4	2	1.2	3	1.8
New Zealand	323	13.6	225	9.5	10	0.41	2	0.08	24	1.0	22	0.89	40	1.7
Nicaragua	260	7.5	91	2.6	6	0.17	9	0.27	46	1.4	19	0.52	89	2.6
Niger	1107	13.4	345	4.0	50	0.59	4	0.06	477	5.9	83	1.1	148	1.7
Nigeria	3726	4.6	1924	2.4	19	0.02	29	0.04	1110	1.3	306	0.39	338	0.43
North Macedonia	110	8.9	63	5.1	4	0.33	0	0.00	9	0.74	10	0.82	24	1.9
Norway	392	13.5	304	10.5	13	0.44	0	0.00	20	0.67	25	0.86	30	1
Oman	312	9.0	194	5.4	7	0.25	5	0.17	35	1.1	21	0.61	50	1.5
Pakistan	9451	9.1	3400	3.1	2626	2.5	429	0.45	934	1.0	213	0.21	1849	1.8
Panama	184	7.9	83	3.6	6	0.25	6	0.25	18	0.78	9	0.38	62	2.7
Papua New Guinea	305	7.3	78	1.9	18	0.46	4	0.09	136	3.3	13	0.32	56	1.3

Paraguay	339	10.0	194	5.8	14	0.46	5	0.16	23	0.67	29	0.88	74	2.1
Peru	1335	7.3	437	2.4	30	0.16	120	0.65	106	0.58	128	0.68	514	2.8
Philippines	6538	11.9	2915	5.3	144	0.27	45	0.08	2453	4.4	441	0.81	540	0.97
Poland	2073	9.3	1070	4.8	193	0.84	14	0.06	168	0.79	217	0.96	411	1.8
Portugal	866	14.6	471	8.0	66	1.1	4	0.06	103	1.7	48	0.82	174	2.9
Puerto Rico	180	11.8	138	9.1	6	0.38	0	0.00	10	0.64	17	1.1	9	0.58
Qatar	98	4.4	58	2.7	3	0.18	1	0.06	7	0.33	10	0.40	19	0.78
Republic of Moldova	288	11.9	96	4.1	14	0.59	0	0.00	65	2.7	58	2.3	55	2.2
Romania	1371	12.1	702	6.2	83	0.72	11	0.10	189	1.6	175	1.5	211	1.9
Russian Federation	10365	12.4	4728	5.7	749	0.88	76	0.09	922	1.1	1355	1.6	2535	3
Rwanda	469	8.2	121	2.1	28	0.49	0	0.00	127	2.1	17	0.30	176	3.2
Saint Lucia	3	2.8	2	1.9	0	0.00	0	0.00	0	0.00	0	0.00	1	0.92
Samoa	5	6.4	3	3.8	0	0.00	0	0.00	1	1.3	0	0.00	1	1.3
Sao Tome and Principe	12	14.0	1	1.4	0	0.00	0	0.00	5	5.4	1	1.4	5	5.8
Saudi Arabia	1829	7.0	1254	4.8	51	0.19	39	0.14	164	0.64	131	0.49	190	0.74
Senegal	979	14.5	214	3.1	51	0.75	12	0.17	480	7.1	39	0.60	183	2.8
Serbia	520	10.6	323	6.6	21	0.42	5	0.10	32	0.67	57	1.1	82	1.7
Sierra Leone	351	9.5	5	0.11	1	0.02	1	0.02	271	7.1	11	0.42	62	1.8
Singapore	441	11.6	270	7.1	8	0.21	2	0.05	55	1.4	44	1.2	62	1.7
Slovakia	286	8.3	154	4.6	37	1.1	1	0.03	11	0.31	47	1.3	36	1
Slovenia	133	11.1	82	6.9	5	0.40	0	0.00	5	0.40	16	1.3	25	2
Solomon Islands	19	6.2	3	1.0	2	0.58	1	0.32	12	4.0	1	0.32	0	0
Somalia	446	8.3	217	4.0	55	1.1	10	0.22	68	1.3	21	0.40	75	1.4

South Africa	3299	10.1	1577	4.8	355	1.2	50	0.16	628	1.9	359	1.1	330	0.99
South Sudan	362	8.1	122	2.7	53	1.3	3	0.07	114	2.5	18	0.42	52	1.2
Spain	3017	10.2	1612	5.4	166	0.54	8	0.02	389	1.3	421	1.4	421	1.5
Sri Lanka	458	4.0	257	2.3	87	0.75	11	0.09	18	0.16	23	0.20	62	0.55
Sudan	1315	6.8	676	3.3	190	1.0	11	0.06	275	1.6	43	0.24	120	0.65
Suriname	27	8.8	12	3.9	0	0.00	1	0.34	9	2.9	2	0.68	3	0.97
Sweden	588	11.6	372	7.3	17	0.33	9	0.17	45	0.90	90	1.8	55	1.1
Switzerland	488	10.6	308	6.7	15	0.32	7	0.16	30	0.64	54	1.2	74	1.6
Syrian Arab Republic	502	4.9	237	2.3	26	0.25	14	0.14	51	0.50	55	0.54	119	1.2
Tajikistan	360	8.2	107	2.3	24	0.52	1	0.03	55	1.2	19	0.37	154	3.8
Tanzania, United Republic of	2228	9.2	755	3.1	798	3.5	14	0.06	404	1.6	83	0.35	174	0.73
Thailand	6276	15.2	1974	4.9	304	0.71	100	0.24	3072	7.3	266	0.64	560	1.4
The Netherlands	918	11.0	613	7.4	63	0.73	4	0.05	40	0.48	101	1.2	97	1.2
The Republic of the Gambia	213	20.7	18	1.8	10	1.1	0	0.00	172	16.2	3	0.41	10	1.1
Timor-Leste	27	5.8	14	2.9	0	0.00	0	0.00	8	1.7	1	0.25	4	0.89
Togo	308	8.4	108	2.9	27	0.75	9	0.24	95	2.5	10	0.28	59	1.7
Trinidad and Tobago	67	8.1	50	6.1	2	0.24	2	0.22	3	0.37	5	0.62	5	0.58
Tunisia	568	8.3	344	5.0	12	0.17	10	0.15	47	0.69	57	0.83	98	1.4
Türkiye	5726	12.0	2696	5.7	183	0.38	59	0.12	445	0.95	675	1.4	1668	3.5
Turkmenistan	226	7.3	76	2.4	38	1.3	3	0.10	45	1.5	18	0.55	46	1.6
Uganda	1921	11.7	365	2.2	498	3.5	11	0.07	839	4.7	53	0.33	155	0.93

Ukraine	2661	10.2	1178	4.5	227	0.86	23	0.09	198	0.77	380	1.5	655	2.5
United Arab Emirates	131	1.8	85	1.1	2	0.03	0	0.00	11	0.15	5	0.07	28	0.36
United Kingdom	3502	10.1	2333	6.7	249	0.71	34	0.10	239	0.70	328	0.94	319	0.91
United States of America	28769	17.2	21032	12.5	877	0.53	238	0.14	1233	0.74	2685	1.6	2704	1.6
Uruguay	228	12.4	125	6.8	13	0.70	6	0.32	10	0.53	27	1.5	47	2.6
Uzbekistan	1521	8.5	527	2.9	169	0.91	13	0.07	206	1.2	199	1.1	407	2.4
Vanuatu	5	3.8	1	0.73	0	0.00	0	0.00	4	3.1	0	0.00	0	0
Venezuela	1143	7.7	593	4.0	27	0.18	20	0.13	109	0.72	117	0.77	277	1.8
Viet Nam	8450	14.9	2202	3.9	599	1.1	39	0.07	3293	5.8	171	0.30	2146	3.8
Yemen	1281	10.2	571	4.5	185	1.5	5	0.04	182	1.6	120	0.93	218	1.7
Zambia	625	8.6	178	2.5	161	2.3	4	0.07	179	2.4	23	0.35	80	1.1
Zimbabwe	613	10.1	189	3.0	116	2.0	8	0.14	205	3.3	22	0.37	73	1.2

ASIR: age-standardized incidence rate (per 100,000 persons); EOGIC: early-onset gastrointestinal cancer; EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer.

Table S7 Model-based attributable fraction estimates of behavioral risk factors for the incidence rates of early-onset gastrointestinal cancers

Cancer	Behavioral risk factors	Model-based attributable fraction estimates (%)
EOGIC	Diet high in red meat	12.78
	Diet high in sodium	4.01
	Diet high in trans fatty acids	4.48
	Diet low in calcium	4.00
	Diet low in fiber	2.47
	High alcohol use	2.32
	Smoking	8.17
EOCRC	Diet high in red meat	4.65
	Diet high in sodium	5.80
	Diet low in fiber	5.42
	High alcohol use	3.14
	Low physical activity	3.86
	Smoking	11.29
EOEC	Chewing tobacco	40.70
	High alcohol use	1.57
	Diet low in calcium	14.30
	Diet low in nuts and seeds	5.34
	Smoking	5.28
EOGC	Diet high in trans fatty acids	6.68
	Chewing tobacco	53.86
	Diet low in nuts and seeds	4.41
EOLC	Diet high in red meat	20.87
	Diet low in calcium	0.93
	Drug use	17.11

	High alcohol use	7.39
	Secondhand smoke	20.43
EOPC	High alcohol use	3.75
	Smoking	23.97
EOSC	Diet high in trans fatty acids	12.44
	Diet high in sodium	15.41
	Diet low in fiber	2.64
	High alcohol use	6.88
	Smoking	8.92

EOGIC: early-onset gastrointestinal cancer; EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer.

Table S8 Ecological incidence rate ratios and model-based attributable fraction estimates of behavioral risk factors for the incidence rates of early-onset gastrointestinal cancer after adjustment for high body-mass index, high fasting plasma glucose, and chronic hepatitis B prevalence.

Cancer	Behavioral risk factors	Ecological incidence	Model-based attributable
		rate ratios (95% CI)	fraction estimates (%)
EOGIC	Diet high in red meat	1.2159 (1.2053-1.2266)	11.57
	Diet high in sodium	1.0130 (1.0072-1.0189)	1.53
	Diet high in trans fatty acids	1.0457 (1.0413-1.0500)	4.03
	Diet low in calcium	1.0478 (1.0386-1.0572)	2.26
	Diet low in fiber	1.0482 (1.0413-1.0552)	2.68
	High alcohol use	1.0634 (1.0506-1.0762)	2.21
	Smoking	1.2162 (1.2026-1.2300)	9.34
EOCRC	Diet high in red meat	1.1349 (1.1198-1.1502)	7.23
	Diet high in sodium	1.0315 (1.0227-1.0404)	3.69
	Diet low in fiber	1.0549 (1.0433-1.0667)	3.05
	High alcohol use	1.0490 (1.0300-1.0683)	1.70
	Low physical activity	1.1217 (1.1121-1.1313)	3.97
	Smoking	1.2732 (1.2520-1.2947)	11.7
EOEC	Chewing tobacco	1.2934 (1.2823-1.3047)	35.09
	High alcohol use	1.0285 (1.0094-1.0479)	0.99
	Diet low in calcium	1.2501 (1.2348-1.2656)	11.60
	Diet low in nuts and seeds	1.1377 (1.1231-1.1524)	4.96
	Smoking	1.2365 (1.2166-1.2567)	10.18
EOGC	Diet high in trans fatty acids	1.0752 (1.0505-1.1005)	6.60
	Chewing tobacco	1.5634 (1.5382-1.5890)	60.77
	Diet low in nuts and seeds	1.0959 (1.0684-1.1241)	3.45
EOLC	Diet high in red meat	1.0729 (1.0556-1.0906)	3.89

	Diet low in calcium	1.0855 (1.0676-1.1036)	4.03
	Drug use	1.0507 (1.0412-1.0603)	3.25
	High alcohol use	1.0373 (1.0133-1.0618)	1.29
	Secondhand smoke	1.3475 (1.3224-1.3731)	20.13
EOPC	High alcohol use	1.1431 (1.0931-1.1955)	5.05
	Smoking	1.5579 (1.4989-1.6192)	22.69
EOSC	Diet high in trans fatty acids	1.1554 (1.1472-1.1636)	13.37
	Diet high in sodium	1.1625 (1.1542-1.1708)	18.56
	Diet low in fiber	1.0603 (1.0516-1.0690)	3.35
	High alcohol use	1.1853 (1.1718-1.1990)	6.56
	Smoking	1.1564 (1.1405-1.1726)	6.80

EOGIC: early-onset gastrointestinal cancer; EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer.

Table S9 Ecological incidence rate ratios and model-based attributable fraction estimates using 5-year lagged behavioral SEVs for early-onset gastrointestinal cancer incidence.

Cancer	Behavioral risk factors	Ecological incidence	Model-based attributable
		rate ratios (95% CI)	fraction estimates (%)
EOGIC	Diet high in red meat	1.2443 (1.2345-1.2540)	12.52
	Diet high in sodium	1.0480 (1.0430-1.0531)	5.61
	Diet high in trans fatty acids	1.0463 (1.0420-1.0507)	5.30
	Diet low in calcium	1.1002 (1.0910-1.1094)	4.99
	Diet low in fiber	1.0497 (1.0438-1.0556)	2.94
	High alcohol use	1.0504 (1.0383-1.0627)	1.61
	Smoking	1.1830 (1.1694-1.1968)	7.66
EOCRC	Diet high in red meat	1.0671 (1.0539-1.0805)	3.41
	Diet high in sodium	1.0574 (1.0498-1.0651)	6.70
	Diet low in fiber	1.1031 (1.0932-1.1132)	6.09
	High alcohol use	1.1202 (1.1006-1.1401)	3.89
	Low physical activity	1.1183 (1.1095-1.1273)	3.76
	Smoking	1.2253 (1.2045-1.2466)	9.39
EOEC	Chewing tobacco	1.3229 (1.3109-1.3351)	40.31
	High alcohol use	1.0455 (1.0263-1.0650)	1.45
	Diet low in calcium	1.3335 (1.3099-1.3574)	16.04
	Diet low in nuts and seeds	1.1341 (1.1189-1.1495)	4.87
	Smoking	1.1913 (1.1663-1.2168)	8.00
EOGC	Diet high in trans fatty acids	1.0879 (1.0662-1.1100)	9.87
	Chewing tobacco	1.4302 (1.4139-1.4468)	51.59
	Diet low in nuts and seeds	1.2220 (1.1930-1.2517)	8.05
EOLC	Diet high in red meat	1.3873 (1.3638-1.4112)	19.61
	Diet low in calcium	1.0226 (1.0031-1.0424)	1.14

	Drug use	1.1314 (1.1188-1.144)	9.94
	High alcohol use	1.2295 (1.1962-1.2638)	7.55
	Secondhand smoke	1.3912 (1.3625-1.4205)	21.95
EOPC	High alcohol use	1.1427 (1.0943-1.1932)	4.63
	Smoking	1.5792 (1.5173-1.6437)	22.78
EOSC	Diet high in trans fatty acids	1.0391 (1.0332-1.0449)	4.48
	Diet high in sodium	1.1594 (1.1539-1.1650)	18.19
	Diet low in fiber	1.0697 (1.0622-1.0774)	4.12
	High alcohol use	1.0925 (1.0811-1.1041)	2.98
	Smoking	1.1651 (1.1511-1.1793)	6.93

EOGIC: early-onset gastrointestinal cancer; EOCRC: early-onset colon and rectum cancer; EOEC: early-onset esophageal cancer; EOGC: early-onset gallbladder cancer; EOLC: early-onset liver and intrahepatic bile ducts cancer; EOPC: early-onset pancreatic cancer; EOSC: early-onset stomach cancer.