Association between adherence to cancer prevention guidelines and cancer risk: a comprehensive systematic review and dose-response meta-analysis of cohort studies

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Summary

Background No systematic review and meta-analysis has comprehensively assessed the association between adherence to major cancer prevention guidelines and risks of cancers in cohort studies. We aimed to evaluate the associations of adherence to the 2018 and the 2007 World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) and the 2012 American Cancer Society (ACS) guidelines with risks of multiple cancer outcomes.

Methods This systematic review and meta-analysis was conducted by searching cohort studies across PubMed, Web of Science, Embase, and Scopus, from database inception to July 31, 2025. We assessed associations between adherence to the three major global cancer prevention guidelines: the 2018 WCRF/AICR guidelines, the 2007 WCRF/AICR guidelines, and the 2012 ACS guidelines, and the risk of total cancer, obesity-related cancer, and 13 site-specific cancers (Colorectal, Breast, Lung, Prostate, Bladder, Kidney, Stomach, Pancreas, Esophagus, Liver, Ovary, Uterus, Gallbladder). Hazard ratios (HRs) with 95% confidence intervals (CIs) were extracted to evaluate risks of cancers. DerSimonian and Laird random-effects models were used to pool effect sizes, and the I^2 statistic was employed to quantify heterogeneity. The strength of associations was quantified by the magnitude of HRs and 95% CIs. A qualitative synthesis was undertaken to assess additional cancers. Study quality was evaluated using the Newcastle-Ottawa Scale. Publication bias was examined by funnel plots, Egger's test, and Begg's test.

Findings This study comprised 28 cohort articles, examining 15 cancer types for quantitative analysis and 15 additional cancer types for qualitative analysis. It revealed that adherence to cancer prevention guidelines was associated with a significant 14% reduction in total cancer risk (HR = 0.86, 95% CI: 0.83–0.88, I^2 = 68.1%). Significant risk reductions were consistently observed across three guidelines for the following cancers: colorectal cancer (HR = 0.69, 95% CI: 0.63–0.74, I^2 = 65.3%), breast cancer (HR = 0.80, 95% CI: 0.74–0.85, I^2 = 64.5%), lung cancer (HR = 0.80, 95% CI: 0.69–0.91, I^2 = 83.6%), kidney cancer (HR = 0.62, 95% CI: 0.56–0.69, I^2 = 22.7%), esophageal cancer (HR = 0.61, 95% CI: 0.52–0.70, I^2 = 0.0%), obesity-related cancers (HR = 0.78, 95% CI: 0.71–0.85, I^2 = 59.3%), uterus cancer (HR = 0.65, 95% CI: 0.47–0.83, I^2 = 89.9%). In contrast, no significant associations were found for prostate cancer (HR = 1.00, 95% CI: 0.93–1.06, I^2 = 52.6%) or ovarian cancer (HR = 0.87, 95% CI: 0.67–1.06, I^2 = 66.4%), findings that were consistent across all three guidelines.

Interpretation Adherence to cancer prevention guidelines was associated with reduced risks of total cancer and multiple major cancers, while no significant associations were observed for prostate cancer or ovarian cancer. These findings reinforce the importance of integrating cancer prevention guidelines into public health strategies for cancer prevention. Further research is warranted to elucidate associations of 2018 WCRF/AICR with risk of a broader spectrum of cancers, particularly in Asian populations.

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Keywords: 2018 WCRF/AICR guidelines; 2007 WCRF/AICR guidelines; 2012 ACS guidelines; Cancer risk; Diet; Lifestyle

Research in context

Evidence before this study

Adherence to major cancer prevention guidelines: the 2018 World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR), the 2007 WCRF/AICR, and the 2012 American Cancer Society (ACS) have been linked to reduced cancer risk in prior studies. We searched PubMed (Medline), Web of Science, Embase, and Scopus from inception through July 31, 2025. Using the terms "cancer prevention guideline", "WCRF/AICR", "World Cancer Research Fund/American Institute for Cancer Research", "American Cancer Society", and "ACS guidelines", combined with "cancer" or "cancer incidence", for papers published in English and study designs that were reviews. Our search yielded three related systematic reviews. However, only two previous meta-analyses had evaluated specific guidelines (the 2018 and the 2007 WCRF/AICR), respectively. No one systematic review and dose-response meta-analysis assessed the association of three major cancer prevention guidelines on cancer risks focus on cohort studies. Notably, the paucity of evidence regarding site-specific cancers, particularly those with lower incidence rates, has resulted in insufficient investigation, inconsistent findings, or a complete absence of systematic review concerning their associations in the meta-analysis studies.

Added value of this study

This is the first study provided the most comprehensive and updated meta-analysis to date evaluating the association between adherence to three major cancer prevention guidelines (2018/2007 WCRF/AICR, 2012 ACS) and risks of site-specific cancer, obesity-related cancers, and total cancer. Our results demonstrated consistent inverse associations between adherence to all three guidelines and the risks of total cancer, colorectal cancer, breast cancer, lung cancer, kidney cancer, esophageal cancer, obesity-related cancers, and uterus cancer, whereas no significant associations were observed for prostate cancer or ovarian cancer. Importantly, this study also provided new evidence on less commonly investigated malignancies through qualitative analysis.

Implications of all the available evidence

These findings strengthened evidence-based advocacy for cancer prevention guidelines adherence in public health practice to mitigate multi-cancer risk. In addition, the absence of significant associations for certain cancer types, together with the limited evidence for underrepresented malignancies, highlighted the need for future studies to further examine the associations between adherence to the 2018 WCRF/AICR and a broader range of cancers, with particular attention to Asian populations.

Introduction

By 2040, the global cancer incidence is projected to exceed 29.5 million, with an estimated 30%–50% of these cases linked to modifiable lifestyle and environmental factors.[1] This suggests that a significant proportion of cancer cases could potentially be prevented through lifestyle modifications. Lifestyle factors such as diet, physical activity, and body composition have been consistently associated with the risk of several common cancers, including breast cancer and colorectal cancer.[2,3]

Recognizing this substantial preventable burden, the World Cancer Research Fund and the American Institute for Cancer Research (WCRF/AICR) have dedicated over two decades to systematically evaluating the burgeoning scientific literature on diet, nutrition, physical activity, and cancer. This culminated in a series of landmark expert reports, published in 1998, 2007, and 2018, aimed at reducing cancer incidence, enhancing public health, and improving the lives of cancer survivors.[4,5]

The 2007 WCRF/AICR report established eight core and two special cancer prevention recommendations, providing actionable guidance for individuals and policymakers. These advised individuals to: maintain healthy weight; engage in regular physical activity; limit energy-dense foods and sugary drink; prioritize plant-based foods; restrict red and processed meat intake; limit alcohol consumption; reduce salt and avoid moldy grains or legumes; strive to meet nutritional needs through diet alone; breastfeed infants; and for cancer survivors, follow all these recommendations. These guidelines have also informed policy initiatives by governments and global health organizations such as the WHO.[5,6] However, the 2007 WCRF/AICR were not accompanied by an official standardized scoring system.

The subsequent 2018 Third Expert Report represented a significant evolution, building upon its predecessors while refining the conceptual framework.[4,7] Although the core public health messages remained largely consistent with 2007, the 2018 update notably emphasized a holistic "suite" of healthy lifestyle patterns over isolated factors. Key revisions included the removal of the specific "limit salt intake" recommendation due to evolving evidence, the explicit addition of "limit sugar-sweetened drinks" (previously referenced in the 2007 WCRF/AICR guidelines), an increase in the recommended daily dietary fiber intake (from ≥25 g to ≥30 g), clearer quantification of physical activity targets (≥150 min moderate or ≥75 min vigorous activity weekly), and a heightened focus on preventing weight gain throughout adulthood and minimizing sedentary time.[4] To facilitate consistent epidemiologic application, Shams-White and colleagues subsequently developed the standardized 2018 WCRF/AICR Score, encompassing eight core recommendations with an optional breastfeeding component, which has since been widely adopted.[8] Similar to the 2007 WCRF/AICR recommendations, the ACS guidelines were not formally accompanied by a unified scoring methodology.

Concurrently, the American Cancer Society (ACS) issued its own evidence-based Nutrition and Physical Activity Guidelines, updated in 2012, which align closely with the WCRF/AICR principles, advocating for healthy weight maintenance, regular physical activity, a plant-focused diet, and limited alcohol intake.[9,10]

Substantial research has investigated the association of adherence to the 2018 WCRF/AICR, the 2007 WCRF/AICR, and the 2012 ACS with risk of cancer.[11–14] Nevertheless, only two meta-analysis reviews have quantitatively evaluated this body of evidence. A meta-analysis by Solans et al. (2020), which included 38 studies (13 cross-sectional, 17 cohort, and 8 case-control studies), reported that adherence to the 2007 WCRF/AICR was associated with a reduced risk of breast cancer, colorectal cancer, and mortality. However, this review was constrained by its narrow scope, encompassing only five cancer types, with pancreatic and lung cancers represented by merely two studies each.[15] More recently, Malcomson et al. (2023) conducted a systematic review and meta-analysis on adherence to the 2018 WCRF/AICR across 18 studies (11 cohort and 7 case-control) and nine cancer types. Despite broader site-specific coverage, only breast cancer and colorectal cancer were supported by more than two studies, underscoring a limited evidence base for other cancers.[16]

To date, the scarcity of studies for most cancer sites has led to substantial heterogeneity and limited reliability in the current evidence base. In addition, no comprehensive systematic review and meta-analysis has yet assessed the associations between adherence to the three major cancer prevention guidelines and the risk of cancers based on cohort study designs. Therefore, this review was conducted to comprehensively evaluate the impact of adherence to three major cancer prevention guidelines (2007 WCRF/AICR, 2018 WCRF/AICR, and 2012 ACS) on cancer risk through three primary objectives: 1) Quantifying associations with risk of total cancer, obesity-related cancers, and 13 site-specific cancers; 2) Establishing dose-response relationships for adherence to cancer prevention guidelines and cancer risk; and 3) Conducting qualitative analyses of associations between the three guidelines and 15 additional cancer types.

Methods

This systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.[17] No review protocol was prepared for this study. The literature search and preliminary analysis were conducted within a short timeframe to ensure timeliness and to provide evidence to inform forthcoming cancer prevention guidelines.

Ethics statement

Ethical approval and informed consent were not required, as this study did not involve patient-identifiable data.

Search strategy and selection criteria

A comprehensive literature search was conducted across four databases: PubMed (Medline), Wed of science, Embase, and Scopus from inception through July 31, 2025. Search terms included variations of "WCRF", "World Cancer Research Fund", "cancer prevention guideline", "cancer prevention score", "American Cancer Society score", "American Cancer Society guidelines", "ACS guidelines", and "ACS score", combined with "cancer" or "cancer incidence" (detailed strategy provided in eTable 1). Two independent reviewers (J.F. and L.T.) screened studies through three sequential stages: title assessment, abstract evaluation, and full-text appraisal. Discrepancies were resolved through discussion with a senior reviewer (S.S.). Studies were included if they met all criteria: (1) full-text availability in English; (2) study design was prospective cohort; (3) exposure defined as adherence to the 2018 WCRF/AICR, the 2007 WCRF/AICR, or the 2012 ACS cancer prevention guidelines (diet-specific exposures excluded); (4) outcome reporting cancer incidence (any type); and (5) extractable hazard ratios (HRs) with 95% confidence intervals (CIs). Exclusion criteria comprised: (1) non research articles (e.g., reviews, meta-analyses), except studies presenting original analyses alongside meta-analyses; (2) conference abstracts; and (3) inaccessible full texts.

Data extraction and quality assessment

Data extraction and quality assessment were performed independently by two reviewers (J.F. and L.T.). Discrepancies were resolved through consultation with a senior reviewer (S.S.). Extracted study characteristics included author, publication year, population country, name of cohort study, participant age, cancer prevention guideline type, guideline score range, cancer type, follow-up duration, case number, and total population size (eTable 2). Study quality was evaluated using the Newcastle-Ottawa Scale (NOS; Appendix II), with scores categorized as follows: 0–3 (low quality), 4–6 (moderate quality), and 7–9 (high quality).[18]

Data synthesis

All meta-analyses were conducted using STATA (MP 17.0). All statistical tests were two-tailed, with $P < 0.05$ considered significant. The HRs with 95% CIs derived from multivariable-adjusted models were extracted. The HRs and 95% CIs, which were extracted from highest category vs the lowest category, were used for primary meta-analyses. The per 1 point increment HRs and 95% CIs were used for dose-response meta-analyses. In addition to extracting HRs and 95% CIs, we also recorded whether the included studies assessed the proportional hazards assumption for Cox regression models. The specific multivariable-adjusted models utilized in each study, along with details regarding the assessment of the assumption, are summarized in eTable 3. Pooled estimates were generated using DerSimonian and Laird random-effects models[19] and visualized in forest plots. The strength of associations was quantified by the magnitude and precision of pooled HRs with 95% CIs. Furthermore, to account for methodological heterogeneity in the operationalization of cancer prevention guidelines, we performed meta analyses stratified by guideline type (2018 WCRF/AICR, 2007 WCRF/AICR, and 2012 ACS). Heterogeneity was assessed via I^2 statistics and Cochran's Q test,[20] with $P < 0.10$ indicating statistical significance. Sources of heterogeneity were explored through subgroup analyses by follow up year, geographical location, sample size of case, study quality, diet assessment tool, menopausal status for breast cancer and anatomic subsite for colorectal cancer.[15,16] For cancer types with high heterogeneity, subgroup analyses were only performed when at least one subgroup had three studies were available. Publication bias was evaluated using Egger's and Begg's tests[7] when $\geq$10 studies were available, with funnel plots visualizing study symmetry.

Role of funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Study characteristics

Fig. 1 summarizes the literature search and screening process. Initial database searches identified 76,547 records. After removing 11,584 duplicates, 64,963 titles were screened, yielding 109 abstracts for evaluation. Full-text assessment of 37 articles resulted in 28 articles meeting inclusion criteria.[11–14,21–44] These comprised 13 articles assessing adherence to the 2018 WCRF/AICR guidelines, 12 evaluating the 2007 WCRF/AICR guidelines, and four examining the 2012 ACS guidelines. Cancer related outcomes included total cancer (n = 11); breast cancer (n = 17); colorectal cancer (n = 15); prostate cancer (n = 9); lung cancer (n = 8); stomach cancer, kidney cancer, pancreas cancer, bladder cancer, uterus cancer (n = 5); esophageal cancer, liver cancer, ovarian cancer, obesity-related cancers (n = 4); gallbladder cancer (n = 3). Two articles investigated melanoma, non-Hodgkin lymphoma, leukemia, head and neck cancer, and digestive tract cancers. This review also considered the articles that assessed the associations with the other cancer risk, but only one article respectively assessed the risk of oral cancer, thyroid cancer, multiple myeloma, small intestine cancer, cervix cancer, larynx cancer, brain cancer, Hodgkin lymphoma, upper aerodigestive tract cancers (UADT) cancers, and upper digestive tract cancers. Most studies focused on Western populations, with the United States predominating (n = 13). The United Kingdom contributed 4 studies, while Canada, Spain, Sweden, and Europe each contributed 2 studies. Single studies originated from France, Australia, and South Korea (n = 1). (eFig. 1 and eTable 2). The median duration of follow-up across the cohort studies ranged from 3 years to 28 years. Across all included studies, adherence to the 2018 WCRF/AICR, the 2007 WCRF/AICR, and the 2012 ACS guidelines were operationalized using study-specific data and guideline-defined thresholds. No standardized scoring systems exist for the 2007 WCRF/AICR or the 2012 ACS guidelines, which may contribute to heterogeneity in adherence assessment. Although a standardized scoring system for the 2018 WCRF/AICR standardized scoring methodology has been developed,[8] methodological heterogeneity persisted across studies included in our review. This is because differences in study populations and available variables prevented full application of the standardized system. Information on the variables used in each study is summarized in Table 1, and specific operational thresholds are provided in Appendix I.

eTable 3 summarizes the adjustment models used and the assessment of the proportional hazards (PH) assumption in the included studies. Of the 28 studies, 13 (46.43%) conducted tests for the PH assumption

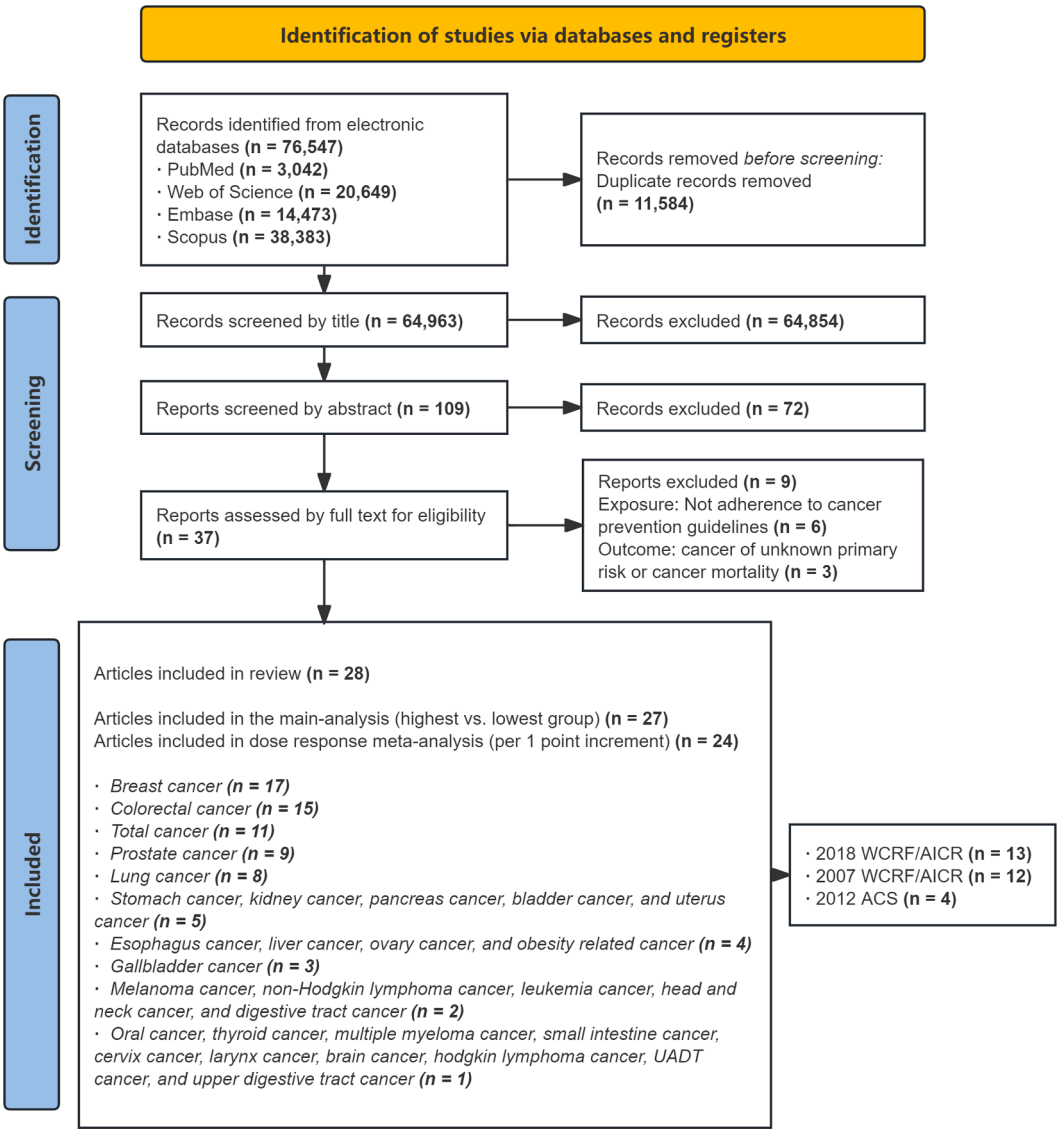

Fig. 1: Flowchart of study selection.

prior to using the Cox proportional hazards model. Regarding dietary assessment, 96.43% (n = 27) of the studies employed Food Frequency Questionnaires (FFQ) to evaluate dietary intake. All included studies used questionnaires to assess physical activity levels, as detailed in eTable 4.

Study quality and publication bias

The majority of included studies (92.86%; n = 26) were identified as high-quality according to the Newcastle-Ottawa Scale, with detailed ratings presented in eTable 5. Egger's test, Begg's test and funnel plot indicated no significant evidence of publication bias between cancer prevention guidelines and risks of total cancer, colorectal cancer, breast cancer, lung cancer (P > 0.05) (Tables 2 and 3; eFig. 2).

Association of cancer prevention guidelines with total cancer risk

We performed categorical random-effects meta-analyses based on 27 articles and dose-response meta-analyses encompassing 24 articles, with primary focus on 13 site-specific cancers, total cancer, and obesity-related cancers. Complementary qualitative analyses extended examination to 16 additional cancer types. Adherence to cancer prevention guidelines was associated with a significant reduction in total cancer risk. Pooled results from 15 studies showed a 14% lower incidence (HR = 0.86, 95% CI: 0.83–0.88), though substantial heterogeneity was observed (I^2 = 68.1%). This protective effect was consistent across guidelines: the 2018 WCRF/AICR (HR = 0.87, 95% CI: 0.84–0.89; I^2 = 47.5%; n = 9), the 2007 WCRF/AICR (HR = 0.80,

Study	Year	Body weight	Physical activity	Plant foods	Animal foods	Alcohol	Fast food	Sugary drinks	Dietary supplements	Breast feeding	Cancer survivors	Score range	NOS
2018 WCRF/AICR													
Barrios-Rodríguez[24]	2020	✔	✔	✔	✔	✔	✔	✔		✔		0–7[a]	8
Barrubés[25]	2020	✔	✔	✔	✔	✔	✔	✔				0–7	9
Kaluza[31]	2020	✔	✔	✔	✔	✔	✔	✔				0–7	8
Kaluza (Simplified)[b31]	2020	✔	✔	✔	✔	✔	✔	✔	✔			0–8	8
Karavasiloglou[32]	2019	✔	✔	✔	✔	✔	✔	✔		✔		0–7[a]	7
Karavasiloglou[33]	2022	✔	✔	✔	✔	✔		✔				0–6	7
Lee[35]	2023	✔	✔	✔	✔	✔	✔	✔		✔		0–7[a]	8
Malcomson[37]	2024	✔	✔	✔	✔	✔						0–5	8
Malcomson[11]	2023	✔	✔	✔	✔	✔	✔	✔				0–7	8
Onyeaghala[40]	2020	✔	✔	✔	✔	✔		✔				0–7	8
Peng[12]	2024	✔	✔	✔	✔	✔	✔	✔				0–7	9
Petimar[14]	2019	✔	✔	✔	✔	✔	✔	✔				0–3	6
Song[42]	2023	✔	✔	✔	✔	✔	✔	✔				0–7	7
Zhang[44]	2020	✔	✔	✔	✔	✔	✔	✔		✔		0–7[a]	7

Study	Year	Body weight	Physical activity	Plant foods	Animal foods	Alcohol	FPWG[c]	Salt	Dietary supplements	Breast feeding	Cancer survivors	Score range	NOS
2007 WCRF/AICR													
Catsburg[26]	2014	✔	✔	✔	✔	✔	✔	✔				0–7	8
Harris[27]	2016	✔	✔	✔	✔	✔	✔		✔			0–7	8
Hastert[28]	2013	✔	✔	✔	✔	✔	✔					0–6	9
Hastert[22]	2016	✔	✔	✔	✔	✔	✔					0–6	9
Jones[29]	2018	✔	✔	✔	✔	✔	✔	✔		✔		0–7[a]	6
Lavalette[34]	2018	✔	✔	✔	✔	✔	✔	✔	✔			0–8	9
Makarem[36]	2015	✔	✔	✔	✔	✔	✔	✔				0–7	8
Nomura[38]	2016	✔	✔	✔	✔	✔	✔	✔				0–7	9
Nomura[39]	2016	✔	✔	✔	✔	✔	✔	✔				0–7	9
Nomura[21]	2016	✔	✔	✔	✔	✔	✔	✔				0–8	7
Romaguera[43]	2012	✔	✔	✔	✔	✔	✔	✔		✔		0–6[d]	8
Xu[13]	2019	✔	✔	✔	✔	✔			✔			0–6	8

Study	Year	Body weight	Physical activity	Healthy diet	Alcohol	Score range	NOS
2012 ACS							
Anderson[23]	2016	✔	✔	✔	✔	0–4	8
Catsburg[26]	2014	✔	✔	✔	✔	0–6	8
Kabat[30]	2015	✔	✔	✔	✔	0–11	7
Pichardo[41]	2022	✔	✔	✔	✔	0–8	7

Abbreviations: FPWG, food that promote weight gain; WCRF/AICR, World Cancer Research Fund (WCRF)/American Institute for Cancer Research (AICR); NOS, Newcastle-Ottawa Scale; ACS, American Cancer Society. [a]The total scores ranged from 0 to 7 points (from 0 to 8 points when breastfeeding was included). [b]This study use Simplified-WCRF/AICR 2018 score. [c]Food that promotes weight gain: Limit consumption of energy-dense foods and avoid sugary drinks. [d]The total scores ranged from 0 to 6 points in men and 0 to 7 points in women.

Table 1: **Summary of included studies on the cancer prevention guidelines.**

95% CI: 0.68–0.91; I^2 = 76.5%; n = 3), and the 2012 ACS (HR = 0.86, 95% CI: 0.78–0.94; I^2 = 86.6%; n = 3). Dose-response meta-analyses confirmed these results (Tables 2 and 3; eFig. 3). We explored the sources of heterogeneity in the association between adherence to cancer prevention guidelines and total cancer risk. In the categorical meta-analysis, inverse association was found across follow up year, geographical regions, and case sizes, although substantial heterogeneity was present; notably, no significant association was found in studies from Asia (I^2 = 90.0%; n = 2). Adherence to the 2018 WCRF/AICR guideline was consistently associated with lower total cancer risk across subgroups. Specifically, similar inverse associations were observed irrespective of follow-up duration or case sizes, without heterogeneity in longer follow-up cohorts (I^2 = 0.0%; n = 5) and larger cohorts (I^2 = 0.0%; n = 6). Regionally, significant inverse associations were observed in North America (I^2 = 0.0%; n = 2), Europe (I^2 = 0.0%; n = 4), and Oceania (n = 1), whereas results in Asia

Outcome	Exposure	No.[a]	Hazard ratio (95% CI)	I^2	$P_{heterogeneity}$	Publication bias	Subgroup analysis
Total cancer	Cancer prevention guidelines	15	0.86 (0.83, 0.88)	68.10%	<0.001	Egger: 0.28 Begg: 0.22	✔
	2018 WCRF/AICR	9	0.87 (0.84, 0.89)	47.50%	0.055		✔
	2007 WCRF/AICR	3	0.80 (0.68, 0.91)	76.50%	0.014		
	2012 ACS	3	0.86 (0.78, 0.94)	86.60%	<0.001		
Colorectal cancer	Cancer prevention guidelines	21	0.69 (0.63, 0.74)	65.30%	<0.001	Egger: 0.29 Begg: 0.82	✔
	2018 WCRF/AICR	10	0.74 (0.70, 0.79)	12.70%	0.33		
	2007 WCRF/AICR	6	0.65 (0.53, 0.78)	43.50%	0.12		
	2012 ACS	5	0.58 (0.52, 0.64)	23.90%	0.26		
Breast cancer	Cancer prevention guidelines	19	0.80 (0.74, 0.85)	64.50%	<0.001	Egger: 0.44 Begg: 0.29	✔
	2018 WCRF/AICR	8	0.87 (0.81, 0.93)	27.00%	0.21		
	2007 WCRF/AICR	8	0.71 (0.59, 0.82)	77.30%	<0.001		✔
	2012 ACS	3	0.80 (0.75, 0.86)	0.00%	0.50		
Lung cancer	Cancer prevention guidelines	11	0.80 (0.69, 0.91)	83.60%	<0.001	Egger: 0.88 Begg: 0.38	✔
	2018 WCRF/AICR	6	0.74 (0.57, 0.92)	88.50%	<0.001		✔
	2007 WCRF/AICR	2	0.86 (0.74, 0.98)	0.00%	0.91		
	2012 ACS	3	0.88 (0.81, 0.96)	13.50%	0.32		
Prostate cancer	Cancer prevention guidelines	9	1.00 (0.93, 1.06)	52.60%	0.032		✔
	2018 WCRF/AICR	4	1.02 (0.97, 1.08)	0.00%	0.48		
	2007 WCRF/AICR	3	0.86 (0.58, 1.15)	81.90%	0.004		
	2012 ACS	2	1.04 (0.99, 1.08)	0.00%	0.45		
Bladder cancer	Cancer prevention guidelines	7	0.85 (0.79, 0.91)	0.00%	0.57		
	2018 WCRF/AICR	4	0.91 (0.79, 1.02)	0.00%	0.51		
	2007 WCRF/AICR	1	0.84 (0.69, 1.02)	/	/		
	2012 ACS	2	0.83 (0.72, 0.95)	15.80%	0.28		
Kidney cancer	Cancer prevention guidelines	7	0.62 (0.56, 0.69)	22.70%	0.26		
	2018 WCRF/AICR	4	0.63 (0.51, 0.76)	47.50%	0.13		
	2007 WCRF/AICR	1	0.71 (0.54, 0.93)	/	/		
	2012 ACS	2	0.59 (0.51, 0.68)	0.00%	0.39		
Stomach cancer	Cancer prevention guidelines	7	0.76 (0.63, 0.90)	59.90%	0.021		✔
	2018 WCRF/AICR	4	0.84 (0.64, 1.04)	64.60%	0.037		
	2007 WCRF/AICR	1	0.62 (0.46, 0.83)	/	/		
	2012 ACS	2	0.82 (0.27, 1.37)	64.70%	0.092		
Pancreatic cancer	Cancer prevention guidelines	6	0.80 (0.70, 0.90)	30.20%	0.21		
	2018 WCRF/AICR	3	0.72 (0.62, 0.83)	0.00%	0.84		
	2007 WCRF/AICR	1	1.00 (0.78, 1.28)	/	/		
	2012 ACS	2	0.88 (0.66, 1.10)	45.00%	0.18		
Esophageal cancer	Cancer prevention guidelines	5	0.61 (0.52, 0.70)	0.00%	0.99		
	2018 WCRF/AICR	2	0.64 (0.51, 0.77)	0.00%	0.99		
	2007 WCRF/AICR	1	0.58 (0.38, 0.90)	/	/		
	2012 ACS	2	0.59 (0.45, 0.73)	0.00%	0.99		
Liver cancer	Cancer prevention guidelines	5	0.68 (0.54, 0.82)	30.90%	0.22		
	2018 WCRF/AICR	2	0.73 (0.55, 0.91)	0.00%	0.79		
	2007 WCRF/AICR	1	0.85 (0.62, 1.16)	/	/		
	2012 ACS	2	0.54 (0.39, 0.69)	0.00%	0.35		

(Table 2 continues on next page)

Outcome	Exposure	No.[a]	Hazard ratio (95% CI)	I^2	$P_{heterogeneity}$	Publication bias	Subgroup analysis
(Continued from previous page)							
Obesity-related cancer	Cancer prevention guidelines	5	0.78 (0.71, 0.85)	59.30%	0.043		✔
	2018 WCRF/AICR	3	0.77 (0.67, 0.86)	76.50%	0.01		
	2007 WCRF/AICR	1	0.86 (0.75, 0.99)	/	/		
	2012 ACS	1	0.75 (0.57, 0.99)	/	/		
Ovarian cancer	Cancer prevention guidelines	4	0.87 (0.67, 1.06)	66.40%	0.030		✔
	2018 WCRF/AICR	2	0.77 (0.38, 1.15)	83.40%	0.014		
	2007 WCRF/AICR	1	0.99 (0.79, 1.25)	/	/		
	2012 ACS	1	0.95 (0.73, 1.23)	/	/		
Uterus cancer	Cancer prevention guidelines	5	0.65 (0.47, 0.83)	89.90%	<0.001		✔
	2018 WCRF/AICR	3	0.68 (0.58, 0.77)	16.10%	0.30		
	2007 WCRF/AICR	1	0.77 (0.62, 0.94)	/	/		
	2012 ACS	1	0.40 (0.34, 0.46)	/	/		
Gallbladder cancer	Cancer prevention guidelines	3	0.55 (0.24, 0.86)	63.60%	0.60		
	2018 WCRF/AICR	2	0.72 (0.43, 1.01)	10.10%	0.29		
	2012 ACS	1	0.35 (0.20, 0.62)	0.00%	/		

Cancer prevention guidelines including the 2012 ACS, the 2018 WCRF/AICR, the 2007 WCRF/AICR (but if no one studied were not included). Abbreviations: WCRF/AICR, World Cancer Research Fund/American Institute for Cancer Research; ACS, American Cancer Society. [a]No.: Number of studies included in this meta-analysis.

Table 2: **Pooled hazard ratio (HR) and 95% confidence interval (CI) for the associations of adherence to cancer prevention guidelines with cancer risk (highest vs lowest group).**

(I^2 = 90.0%; n = 2) were non-significant. These findings were corroborated by dose-response meta-analyses (Table 4; eFigs. 18–21).

Association of cancer prevention guidelines with gastrointestinal cancers risk

Site-specific analyses revealed strong protective effects against gastrointestinal cancers. For colorectal cancer, pooled results from 21 studies showed a 31% risk reduction (HR = 0.69, 95% CI: 0.63–0.74; I^2 = 65.3%) (Tables 2 and 3; eFig. 4). Consistent protective effects observed across the 2018 WCRF/AICR (HR = 0.74, 95% CI: 0.70–0.79; I^2 = 12.70%; n = 10), the 2007 WCRF/AICR (HR = 0.65, 95% CI: 0.53–0.78; I^2 = 43.50%; n = 6), and the 2012 ACS guidelines (HR = 0.58, 95% CI: 0.52–0.64; I^2 = 23.90%; n = 5). The dose-response meta-analyses yielded congruent results. Subgroup analyses identified geographical region and anatomic site as notable sources of heterogeneity: Europe (I^2 = 0.0%; n = 6), and rectum cancer (I^2 = 40.7%; n = 8) showed low or zero heterogeneity. (Table 4; eFig. 22). A significant inverse association was observed for esophageal cancer, with a 39% risk reduction (HR = 0.61, 95% CI: 0.52–0.70; I^2 = 0.0%; n = 5), which was consistent across all three guidelines and supported by dose-response meta-analyses (Tables 2 and 3; eFig. 12). For stomach cancer, the pooled results of 7 studies indicated a 24% risk reduction (HR = 0.76, 95% CI: 0.63–0.90; I^2 = 59.9%) (Tables 2 and 3; eFig. 10). Methodological heterogeneity was evident across studies. In categorical analysis, only the 2007 WCRF/AICR showed a significant inverse association (HR = 0.62, 95% CI: 0.46–0.83; n = 1), while the 2018 WCRF/AICR (n = 4) and the 2012 ACS (n = 2) showed no significant association. However, dose-response meta-analyses revealed inverse associations for both the 2018 WCRF/AICR (HR = 0.90, 95% CI: 0.82–0.98; I^2 = 31.2%; n = 6) and the 2007 WCRF/AICR (HR = 0.84, 95% CI: 0.78–0.91; n = 1). Subgroup analyses identified follow-up duration and geographical region as sources of heterogeneity. Stronger inverse associations were observed in studies with longer follow-up (I^2 = 30.8%; n = 3) and those conducted in Europe (I^2 = 3.8%; n = 3) (Table 4; eFig. 34).

Association of cancer prevention guidelines with female hormone-related cancers risk

Female hormone-related cancers showed distinct associations. For breast cancer, meta-analysis of 19 studies demonstrated a significant 20% risk reduction (HR = 0.80, 95% CI: 0.74–0.85; I^2 = 64.5%), with consistent results across all three guidelines (Tables 2 and 3; eFig. 5). Heterogeneity was low in studies using the 2018 WCRF/AICR (I^2 = 27.0%; n = 8) and the 2012 ACS guidelines (I^2 = 0.0%; n = 3). Dose–response analysis confirmed these findings, though with some residual heterogeneity. In categorical meta-analyses, adherence to cancer prevention guidelines was

Outcome	Exposure	No.[a]	Hazard ratio (95% CI)	I^2	P_h	Publication bias	Subgroup analysis
Total cancer	Cancer prevention guidelines	11	0.94 (0.93, 0.95)	68.30%	<0.001	Egger: 0.14 Begg: 0.23	✔
	2018 WCRF/AICR	9	0.95 (0.93, 0.96)	61.80%	0.007		✔
	2007 WCRF/AICR	2	0.92 (0.85, 0.99)	89.40%	0.002		
Colorectal cancer	Cancer prevention guidelines	18	0.88 (0.86, 0.90)	18.30%	0.23	Egger: 0.97 Begg: 0.54	
	2018 WCRF/AICR	12	0.88 (0.85, 0.90)	32.10%	0.13		
	2007 WCRF/AICR	6	0.89 (0.86, 0.92)	0.00%	0.54		
Breast cancer	Cancer prevention guidelines	17	0.93 (0.91, 0.95)	55.50%	0.003	Egger: 0.19 Begg: 0.54	✔
	2018 WCRF/AICR	9	0.94 (0.91, 0.97)	62.90%	<0.01		✔
	2007 WCRF/AICR	7	0.91 (0.88, 0.94)	58.10%	0.03		✔
	2012 ACS	1	0.94 (0.90, 0.98)	/	/		
Lung cancer	Cancer prevention guidelines	8	0.89 (0.85, 0.94)	75.40%	<0.001		✔
	2018 WCRF/AICR	7	0.89 (0.83, 0.95)	77.80%	<0.001		✔
	2007 WCRF/AICR	1	0.92 (0.89, 0.96)	/	/		
Prostate cancer	Cancer prevention guidelines	8	0.99 (0.97, 1.02)	43.20%	0.090		✔
	2018 WCRF/AICR	5	1.00 (0.97, 1.03)	41.10%	0.15		
	2007 WCRF/AICR	3	0.98 (0.89, 1.07)	60.80%	0.078		✔
Bladder cancer	Cancer prevention guidelines	6	0.95 (0.92, 0.99)	0.00%	0.50		
	2018 WCRF/AICR	5	0.96 (0.91, 1.01)	2.60%	0.39		
	2007 WCRF/AICR	1	0.94 (0.89, 1.00)	/	/		
Kidney cancer	Cancer prevention guidelines	6	0.86 (0.82, 0.90)	13.90%	0.33		
	2018 WCRF/AICR	5	0.84 (0.80, 0.89)	0.00%	0.53		
	2007 WCRF/AICR	1	0.91 (0.85, 0.99)	/	/		
Stomach cancer	Cancer prevention guidelines	6	0.88 (0.82, 0.93)	31.20%	0.20		
	2018 WCRF/AICR	5	0.90 (0.82, 0.98)	35.80%	0.18		
	2007 WCRF/AICR	1	0.84 (0.78, 0.91)	/	/		
Pancreatic cancer	Cancer prevention guidelines	5	0.91 (0.85, 0.97)	44.10%	0.13		
	2018 WCRF/AICR	4	0.87 (0.82, 0.93)	0.00%	0.93		
	2007 WCRF/AICR	1	1.00 (0.92, 1.08)	/	/		
Obesity-related cancers	Cancer prevention guidelines	5	0.92 (0.91, 0.94)	0.00%	0.46		
	2018 WCRF/AICR	3	0.92 (0.90, 0.94)	35.10%	0.21		
	2007 WCRF/AICR	1	0.94 (0.86, 1.02)	/	/		
	2012 ACS	1	0.94 (0.88, 0.99)	/	/		
Esophageal cancer	Cancer prevention guidelines	3	0.83 (0.77, 0.89)	0.00%	0.94		
	2018 WCRF/AICR	2	0.82 (0.76, 0.89)	0.00%	0.80		
	2007 WCRF/AICR	1	0.74 (0.73, 0.96)	/	/		
Liver cancer	Cancer prevention guidelines	3	0.84 (0.76, 0.91)	32.00%	0.23		
	2018 WCRF/AICR	2	0.80 (0.72, 0.88)	0.00%	0.84		
	2007 WCRF/AICR	1	0.90 (0.81, 0.99)	/	/		
Ovarian cancer	Cancer prevention guidelines	3	0.91 (0.79, 1.03)	78.20%	0.010		
	2018 WCRF/AICR	2	0.88 (0.65, 1.12)	88.00%	0.004		
	2007 WCRF/AICR	1	0.95 (0.89, 1.02)	/	/		
Uterus cancer	Cancer prevention guidelines	4	0.86 (0.81, 0.92)	56.20%	0.077		✔
	2018 WCRF/AICR	3	0.86 (0.78, 0.94)	68.10%	0.044		
	2007 WCRF/AICR	1	0.88 (0.83, 0.94)	/	/		

Cancer prevention guidelines including the 2012 ACS, the 2018 WCRF/AICR, the 2007 WCRF/AICR (but if no one studied were not included). Abbreviations: WCRF/AICR, World Cancer Research Fund/American Institute for Cancer Research; ACS, American Cancer Society. *P_h means the p for heterogeneity.* [a]No.: Number of studies included in this meta-analysis.

***Table 3*: Pooled hazard ratio (HR) and 95% confidence interval (CI) for the dose-response associations of adherence to cancer prevention guidelines with cancer risk.**

associated with a significant reduction in post-menopausal breast cancer risk (HR = 0.76, 95% CI: 0.65–0.87; I^2 = 80.7%; n = 7), whereas no significant association was observed in premenopausal women (I^2 = 45.10%; n = 5). Analyses stratified by guideline version indicated that this differential association by

Outcome	Highest vs lowest meta-analysis					No.[a]	Dose-response meta-analysis			
	No.[a]	Hazard ratio (95% CI)	I^2	P_h	P_i		Hazard ratio (95% CI)	I^2	P_h	P_i
Cancer prevention guidelines and total cancer										
Follow up year					0.67					0.002
≥10 years	9	0.86 (0.83, 0.89)	57.90%	0.015		6	0.95 (0.95, 0.96)	0.00%	0.46	
<10 years	6	0.85 (0.78, 0.91)	79.70%	<0.001		5	0.92 (0.90, 0.94)	52.10%	0.079	
Geographical location					0.64					0.80
North America	6	0.87 (0.83, 0.91)	69.20%	0.006		2	0.95 (0.94, 0.96)	0.00%	0.99	
Europe	6	0.84 (0.80, 0.88)	67.40%	0.009		6	0.94 (0.92, 0.96)	80.30%	<0.001	
Asia	2	0.88 (0.72, 1.04)	90.00%	0.002		2	0.93 (0.85, 1.01)	60.50%	0.11	
Oceania	1	0.82 (0.74, 0.92)	/	/		1	0.94 (0.91, 0.96)	/	/	
Sample size of case					0.60					0.11
≥5000	9	0.89 (0.84, 0.89)	60.20%	0.010		7	0.95 (0.94, 0.96)	59.20%	0.023	
<5000	6	0.84 (0.75, 0.93)	78.80%	<0.001		4	0.92 (0.88, 0.95)	66.50%	0.030	
2018 WCRF/*AICR and total cancer*										
Follow up year					0.92					<0.01
≥10 years	5	0.87 (0.84, 0.89)	0.00%	0.62		5	0.96 (0.95, 0.96)	9.50%	0.35	
<10 years	4	0.87 (0.82, 0.92)	75.90%	0.006		4	0.93 (0.91, 0.94)	7.90%	0.35	
Geographical location					0.63					0.88
North America	2	0.88 (0.85, 0.92)	0.00%	0.62		2	0.95 (0.94, 0.96)	0.00%	0.99	
Europe	4	0.87 (0.85, 0.89)	0.00%	0.44		4	0.95 (0.93, 0.97)	79.50%	0.002	
Asia	2	0.88 (0.72, 1.04)	90.00%	0.002		2	0.93 (0.85, 1.01)	60.50%	0.11	
Oceania	1	0.82 (0.74, 0.92)	/	/		1	0.94 (0.91, 0.96)	/	/	
Sample size of case					0.86					0.34
≥5000	6	0.87 (0.86, 0.89)	0.00%	0.64		6	0.95 (0.94, 0.96)	66.00%	0.012	
<5000	3	0.86 (0.76, 0.97)	83.10%	0.003		1	0.93 (0.90, 0.97)	49.30%	0.14	
Cancer prevention guidelines and colorectal cancer										
Follow up year					0.68					/
≥10 years	13	0.68 (0.61, 0.74)	66.30%	<0.001		/	/	/	/	
<10 years	8	0.70 (0.60, 0.80)	50.60%	0.048		/	/	/	/	
Geographical location					0.062					/
North America	13	0.65 (0.58, 0.72)	64.00%	<0.001		/	/	/	/	
Europe	6	0.74 (0.69, 0.79)	0.00%	0.75		/	/	/	/	
Asia	2	0.80 (0.66, 0.94)	0.00%	0.33		/	/	/	/	
Oceania	/	/	/	/		/	/	/	/	
Sample size of case					0.74					/
≥1000	9	0.68 (0.61, 0.75)	80.40%	<0.001		/	/	/	/	
<1000	12	0.70 (0.62, 0.78)	27.30%	0.18		/	/	/	/	
Study quality					0.46					/
High	18	0.68 (0.62, 0.74)	66.50%	<0.001		/	/	/	/	
Medium	3	0.74 (0.58, 0.90)	59.00%	0.087		/	/	/	/	
Diet assessment tool					0.61					/
FFQ	20	0.69 (0.63, 0.74)	66.90%	<0.001		/	/	/	/	
24 h recall	1	0.58 (0.30, 1.12)	/	/		/	/	/	/	
Anatomic site					<0.001					/
Colon cancer	9	0.67 (0.58, 0.76)	71.3%	<0.001		/	/	/	/	
Rectum cancer	8	0.72 (0.62, 0.82)	40.7%	0.11		/	/	/	/	
Cancer prevention guidelines and breast cancer										
Follow up year					0.34					0.02
≥10 years	11	0.82 (0.75, 0.90)	64.40%	0.002		11	0.94 (0.92, 0.96)	50.40%	0.028	
<10 years	8	0.76 (0.68, 0.85)	66.60%	0.004		6	0.90 (0.88, 0.93)	2.60%	0.40	
Geographical location					0.53					0.53
North America	10	0.79 (0.70, 0.89)	70.30%	<0.001		7	0.94 (0.91, 0.97)	59.60%	0.022	
Europe	8	0.79 (0.71, 0.87)	64.30%	<0.001		8	0.92 (0.90, 0.95)	61.60%	0.011	
Asia	1	0.88 (0.75, 1.04)	/	/		1	0.92 (0.84, 1.01)	/	/	
Oceania	/	/	/	/		1	0.88 (0.81, 0.95)	/	/	

(Table 4 continues on next page)

Outcome	Highest vs lowest meta-analysis					No.[a]	Dose-response meta-analysis			
	No.[a]	Hazard ratio (95% CI)	I^2	P_h	P_i		Hazard ratio (95% CI)	I^2	P_h	P_i
(Continued from previous page)										
Sample size of case					0.40					0.39
≥1500	8	0.83 (0.79, 0.86)	14.70%	0.315		6	0.94 (0.92, 0.96)	51.00%	0.070	
<1500	11	0.77 (0.64, 0.90)	74.60%	<0.001		11	0.92 (0.89, 0.95)	56.00%	0.012	
Diet assessment tool					0.15					0.074
FFQ	18	0.80 (0.75, 0.86)	64.60%	<0.001		16	0.93 (0.91, 0.95)	53.30%	0.006	
24 h recall	1	0.64 (0.46, 0.89)	/	/		1	0.86 (0.79, 0.94)	/	/	
Menopausal status					<0.001					0.012
Pre-menopausal breast cancer	5	0.80 (0.60, 1.00)	45.10%	0.12		7	0.96 (0.89, 1.03)	59.60%	0.021	
Post-menopausal breast cancer	7	0.76 (0.65, 0.87)	80.70%	<0.001		8	0.92 (0.89, 0.95)	38.40%	0.12	
2018 WCRF/AICR and breast cancer										
Follow up year					/					0.098
≥10 years	/	/	/	/		5	0.96 (0.91, 1.01)	63.80%	0.026	
<10 years	/	/	/	/		4	0.91 (0.89, 0.94)	6.60%	0.36	
Geographical location					/					0.31
North America	/	/	/	/		2	1.01 (0.89, 1.14)	77.70%	0.034	
Europe	/	/	/	/		5	0.93 (0.89, 0.97)	56.60%	0.056	
Asia	/	/	/	/		1	0.92 (0.84, 1.01)	/	/	
Oceania	/	/	/	/		1	0.88 (0.81, 0.95)	/	/	
Sample size of case					/					0.73
≥1500	/	/	/	/		2	0.93 (0.87, 0.99)	82.30%	0.018	
<1500	/	/	/	/		7	0.94 (0.90, 0.99)	61.80%	0.015	
Menopausal status					/					0.0008
Pre-menopausal breast cancer	/	/	/	/		6	0.97 (0.89, 1.06)	60.80%	0.026	
Post-menopausal breast cancer	/	/	/	/		6	0.93 (0.90, 0.96)	47.70%	0.089	
2007 WCRF/AICR and breast cancer										
Follow up year					0.16					0.065
≥10 years	5	0.76 (0.62, 0.90)	71.70%	0.007		5	0.93 (0.90, 0.96)	46.70%	0.11	
<10 years	2	0.52 (0.28, 0.75)	61.00%	0.11		2	0.88 (0.84, 0.92)	0.00%	0.53	
Not provided	1	0.76 (0.67, 0.87)	/	/		/	/	/	/	
Geographical location					0.68					0.90
North America	5	0.73 (0.57, 0.88)	70.40%	0.009		4	0.91 (0.89, 0.94)	43.90%	0.15	
Europe	3	0.67 (0.43, 0.91)	87.40%	<0.001		3	0.91 (0.85, 0.97)	75.00%	0.018	
Sample size of case					0.03					0.009
≥1500	4	0.82 (0.77, 0.87)	0.00%	0.60		3	0.94 (0.91, 0.97)	43.60%	0.17	
<1500	4	0.59 (0.40, 0.79)	74.10%	0.009		4	0.88 (0.85, 0.92)	0.00%	0.92	
Diet assessment tool					0.55					0.13
FFQ	7	0.72 (0.59, 0.84)	79.50%	<0.001		6	0.92 (0.89, 0.95)	52.30%	0.062	
24 h recall	1	0.64 (0.46, 0.89)	/	/		1	0.86 (0.79, 0.94)	/	/	
Menopausal status					<0.01					/
Pre-menopausal breast cancer	1	0.67 (0.44, 1.03)	/	/		/	/	/	/	
Post-menopausal breast cancer	3	0.70 (0.41, 0.99)	84.60%	0.002		/	/	/	/	
Cancer prevention guidelines and lung cancer										
Follow up year					0.28					0.40
≥10 years	6	0.87 (0.82, 0.91)	0.00%	0.65		4	0.92 (0.90, 0.95)	0.00%	0.97	
<10 years	5	0.72 (0.47, 0.98)	89.30%	<0.001		4	0.87 (0.75, 0.99)	86.20%	<0.01	
Geographical location					0.40					0.89
North America	6	0.87 (0.82, 0.92)	0.00%	0.58		2	0.93 (0.89, 0.96)	0.00%	0.80	

(Table 4 continues on next page)

Outcome	Highest vs lowest meta-analysis					No.[a]	Dose-response meta-analysis			
	No.[a]	Hazard ratio (95% CI)	I^2	P_h	P_i		Hazard ratio (95% CI)	I^2	P_h	P_i
(Continued from previous page)										
Europe	3	0.82 (0.75, 0.90)	0.00%	0.80		3	0.91 (0.88, 0.94)	0.00%	0.58	
Asia	2	0.61 (0.11, 1.11)	92.10%	<0.001		2	0.84 (0.53, 1.15)	89.90%	<0.001	
Oceania	/	/	/	/		1	0.90 (0.88, 0.94)	/	/	
Sample size of case					0.40					0.56
≥1000	6	0.85 (0.81, 0.90)	0.00%	0.50		4	0.92 (0.89, 0.94)	0.00%	0.70	
<1000	5	0.73 (0.44, 1.02)	84.30%	<0.001		4	0.87 (0.73, 1.01)	85.30%	<0.001	
2018 WCRF/AICR and lung cancer										
Follow up year					0.38					0.39
≥10 years	2	0.83 (0.73, 0.93)	0.00%	0.39		3	0.92 (0.89, 0.96)	0.00%	0.88	
<10 years	4	0.71 (0.45, 0.97)	91.80%	<0.001		4	0.87 (0.75, 0.99)	86.20%	<0.001	
Sample size of case					0.41					0.59
≥1000	3	0.82 (0.75, 0.89)	0.00%	0.66		3	0.91 (0.88, 0.94)	0.00%	0.52	
<1000	3	0.67 (0.32, 1.02)	90.60%	<0.001		4	0.87 (0.73, 1.01)	85.30%	<0.01	
Cancer prevention guidelines and prostate cancer										
Follow up year					0.25					0.66
≥10 years	4	1.04 (0.99, 1.08)	0.00%	0.96		4	0.99 (0.94, 1.03)	34.70%	0.20	
<10 years	5	0.94 (0.77, 1.10)	74.40%	0.004		4	1.00 (0.96, 1.04)	53.70%	0.09	
Geographical location					0.23					0.17
North America	4	1.04 (0.99, 1.08)	0.00%	0.86		2	1.01 (0.95, 1.07)	0.00%	0.40	
Europe	4	0.94 (0.81, 1.07)	78.40%	0.003		4	1.00 (0.97, 1.03)	50.20%	0.11	
Asia	/	/	/	/		1	1.05 (0.95, 1.17)	/	/	
Oceania	/	/	/	/		1	0.93 (0.86, 0.99)	/	/	
Sample size of case					0.37					0.37
≥1000	5	1.03 (1.00, 1.06)	0.00%	0.78		4	1.01 (0.99, 1.03)	0.00%	0.82	
<1000	4	0.88 (0.55, 1.21)	73.50%	0.010		4	0.97 (0.89, 1.05)	58.20%	0.066	
Diet assessment tool					<0.01					0.033
FFQ	8	1.03 (0.998, 1.06)	0.00%	0.85		7	1.00 (0.98, 1.03)	20.50%	0.27	
24 h recall	1	0.54 (0.34, 0.86)	/	/		1	0.88 (0.78, 1.00)	/	/	
Cancer prevention guidelines and stomach cancer										
Follow up year					0.14					
≥10 years	3	0.65 (0.49, 0.81)	30.80%	0.24		/	/	/	/	
<10 years	4	0.84 (0.64, 1.04)	64.60%	0.037		/	/	/	/	
Geographical location					0.68					
North America	2	0.82 (0.27, 1.37)	64.70%	0.092		/	/	/	/	
Europe	3	0.70 (0.57, 0.84)	3.80%	0.35		/	/	/	/	
Asia	2	0.87 (0.47, 1.27)	87.20%	0.005		/	/	/	/	
Sample size of case					0.034					
≥500	2	0.62 (0.50, 0.74)	0.00%	0.99		/	/	/	/	
<500	5	0.86 (0.67, 1.06)	59.80%	0.041		/	/	/	/	
Cancer prevention guidelines and obesity-related cancer										
Follow up year					0.40					
≥20 years	2	0.82 (0.77, 0.86)	0.00%	0.85		/	/	/	/	
<20 years	3	0.75 (0.60, 0.90)	71.50%	0.030		/	/	/	/	
Geographical location					0.003					
North America	4	0.82 (0.78, 0.86)	0.00%	0.82		/	/	/	/	
Oceania	1	0.64 (0.54, 0.76)	/	/		/	/	/	/	
Sample size of case					0.36					
≥2000	3	0.77 (0.67, 0.86)	76.50%	0.014		/	/	/	/	
<2000	2	0.83 (0.73, 0.94)	0.00%	0.37		/	/	/	/	

(Table 4 continues on next page)

Outcome	Highest vs lowest meta-analysis					No.[a]	Dose-response meta-analysis			
	No.[a]	Hazard ratio (95% CI)	I^2	P_h	P_i		Hazard ratio (95% CI)	I^2	P_h	P_i
(Continued from previous page)										
Cancer prevention guidelines and ovarian cancer										
Geographical location					0.56					
North America	1	0.95 (0.73, 1.23)	/	/		/	/	/	/	
Europe	3	0.84 (0.58, 1.10)	76.10%	0.015		/	/	/	/	
Cancer prevention guidelines and uterus cancer										
Follow up year					0.68					
≥10 years	3	0.62 (0.36, 0.88)	93.30%	<0.001		/	/	/	/	
<10 years	2	0.69 (0.50, 0.88)	49.20%	0.16		/	/	/	/	
Geographical location					0.34					0.47
North America	2	0.55 (0.24, 0.85)	93.70%	<0.001		1	0.89 (0.83, 0.95)	/	/	
Europe	3	0.71 (0.58, 0.83)	41.40%	0.18		3	0.86 (0.78, 0.93)	65.00%	0.057	
Sample size of case					0.68					
≥1000	3	0.62 (0.36, 0.88)	93.30%	<0.001		/	/	/	/	
<1000	2	0.69 (0.50, 0.88)	49.20%	0.16		/	/	/	/	

Cancer prevention guidelines including the 2012 ACS, the 2018 WCRF/AICR, the 2007 WCRF/AICR (but if no one studied were not included). P_h means the p for heterogeneity and P_i means the p for interaction (heterogeneity from between groups). We further stratified breast cancer by menopausal status and colorectal cancer by anatomic site. The grouping thresholds were determined based on the number of included studies for each cancer type. The specific thresholds for case numbers were defined as follows: total cancer with ≥5000 cases; obesity-related cancer with ≥2000 cases; breast cancer with ≥1500 cases; colorectal, lung, prostate, and uterine cancer with ≥1000 cases; and stomach cancer with ≥500 cases. For follow-up duration, the thresholds were set at ≥20 years for obesity-related cancers and ≥10 years for all other cancer types. Abbreviations: WCRF/AICR, World Cancer Research Fund/American Institute for Cancer Research; ACS, American Cancer Society; h, hours. [a]No.: Number of studies included in this meta-analysis.

Table 4: **Subgroup analyses for the associations of adherence to cancer prevention guidelines with cancer risk.**

menopausal status was consistent for both the 2018 and the 2007 WCRF/AICR. Additionally, an inverse association was observed in studies with larger sample sizes (HR = 0.83, 95% CI: 0.79–0.86; I^2 = 14.7%; n = 8). These findings were supported by dose-response meta-analyses (Table 4; eFigs. 23–27). Meta-analysis of five studies on uterus cancer demonstrated a 35% risk reduction associated with adherence to cancer prevention guidelines (HR = 0.65, 95% CI: 0.47–0.83; I^2 = 89.9%) (Tables 2 and 3; eFig. 16). All three guidelines showed consistent inverse associations, which were corroborated by dose-response analyses. Inverse associations were observed across all subgroups, without high heterogeneity detected in studies with shorter follow-up duration (n = 2), those conducted in Europe (n = 3), or those with smaller sample sizes (n = 2) (Table 4; eFigs. 37 and 38). Regarding ovarian cancer, four studies indicated no significant correlations within any of three guideline frameworks, whether in categorical or dose-response meta-analyses (Tables 2 and 3; eFig. 15). Substantial heterogeneity persisted across geographical regions in subgroup analyses (Table 4 and eFig. 36).

Association of cancer prevention guidelines with genitourinary cancers risk

Adherence to cancer prevention guidelines showed varying associations across genitourinary cancers. Kidney cancer demonstrated a substantial protective effect, with a 38% risk reduction in the pooled analysis of 7 studies (HR = 0.62, 95% CI: 0.56–0.69; I^2 = 22.7%), which was consistent across all three guidelines (Table 2; eFig. 9). For bladder cancer, a more modest inverse association was observed (HR = 0.85, 95% CI: 0.79–0.91; I^2 = 0.0%; n = 7), however, guideline-specific analysis revealed significance only for the 2012 ACS guidelines (HR = 0.83, 95% CI: 0.72–0.95; I^2 = 15.8%; n = 2) (Table 2 and eFig. 8). In contrast, no significant association was found for prostate cancer in any analysis. These findings were consistent across all subgroup analyses. No heterogeneity was observed in cohorts with longer follow-up (n = 4), those from North America (n = 4), those with larger sample sizes (n = 5), or those whose dietary assessment used FFQs (n = 8) (Table 4; eFigs. 32 and 33). Dose-response meta-analyses corroborated these results (Tables 3 and 4; eFigs. 8 and 9; eFigs. 32 and 33).

Association of cancer prevention guidelines with digestive accessory organ cancers risk

For digestive accessory organ cancers, pancreatic cancer (n = 6) demonstrated a consistent 20% risk reduction (HR = 0.80, 95% CI: 0.70–0.90; I^2 = 30.2%), with only the 2018 WCRF/AICR guidelines showing a inverse association (HR = 0.72, 95% CI: 0.62–0.83; I^2 = 0.0%; n = 3) (Table 2; eFig. 11). Liver cancer showed a 32% risk reduction (HR = 0.68, 95% CI: 0.54–0.82; I^2 = 30.9%; n = 5), predominantly associated with the 2018 WCRF/AICR (HR = 0.73, 95% CI: 0.55–0.91; I^2 = 0.0%; n = 2) and the 2012 ACS guidelines

(HR = 0.54, 95% CI: 0.39–0.69; I^2 = 0.0%; n = 2) (Table 2; eFig. 13). Dose-response meta-anlyses confirmed these results (Table 3; eFig. 11; eFig. 13). Gallbladder cancer analyses, while limited by only three available studies, suggested potential protection (HR = 0.55, 95% CI: 0.24–0.86; I^2 = 63.6%), with one study focusing on the 2012 ACS reporting a substantial inverse association (HR = 0.35, 95% CI: 0.20–0.62) (Table 2; eFig. 17). Due to data limitation, we did not conduct dose–response meta-anlayses on risk of gallbladder cancer.

Association of cancer prevention guidelines with respiratory cancers risk

Adherence to cancer prevention guidelines was associated with a significant 20% reduction in lung cancer risk (HR = 0.80, 95% CI: 0.69–0.91; I^2 = 83.6%; n = 11), similar results were observed across three guidelines. Substantial heterogeneity was observed overall (I^2 = 83.6%) and particularly in studies using the 2018 WCRF/AICR (I^2 = 83.6%; n = 6). Dose–response analyses corroborated these findings (Tables 2 and 3; eFig. 6). Subgroup analyses suggested that follow-up time, geographical region, and sample size contributed to heterogeneity. Significant inverse associations without heterogeneity were consistently observed in studies with longer follow-up (n = 6), those conducted in North America (n = 6) and Europe (n = 3), and those with larger sample sizes (n = 6). In contrast, no significant association was found in Asian cohorts (I^2 = 92.1%; n = 2) or smaller sample sizes (I^2 = 84.3%; n = 5), with high heterogeneity. These results were similar in subgroup analyses restricted to the 2018 WCRF/AICR (Table 3; eFigs. 28–31).

Association of cancer prevention guidelines with obesity-related cancers risk

Adherence to cancer prevention guidelines was associated with a significant 22% reduction in the risk of obesity-related cancers (HR = 0.78, 95% CI: 0.71–0.85; I^2 = 59.3%; n = 5), with consistent results observed across the three guidelines. Dose-response meta-analyses partially confirmed these findings: inverse associations were observed for the 2018 WCRF/AICR (n = 3) and the 2012 ACS (n = 1), whereas the 2007 WCRF/AICR (n = 1) showed no significant association (Tables 2 and 3; eFig. 14). Geographical region appeared to be a source of heterogeneity. A significant inverse association without heterogeneity was observed in North American cohorts (n = 4) (Table 3; eFig. 35).

Association of cancer prevention guidelines with 16 additional cancers risk

Findings from categorical and dose-response meta-analyses across 15 additional cancer types were summarised qualitatively in Figs. 2 and 3. Categorical meta-analysis showed no significant association between cancer prevention guidelines adherence and risk of non-Hodgkin lymphoma, head and neck cancer, thyroid cancer, multiple myeloma, cervical cancer, or laryngeal cancer. A significant inverse association was observed for cancers of the digestive tract, small intestine, Hodgkin lymphoma, and UADT. For melanoma, leukaemia, oral cancer, and upper digestive tract cancers, the evidence remained inconsistent, with some studies indicating a negative association and others showing no association. Notably, Kabat et al. reported that higher adherence to the 2012 ACS guidelines was associated with an increased risk of brain cancer (HR = 1.32, 95% CI: 1.02–1.71).[30] Dose-response meta-analyses generally corroborated the categorical findings; however, discrepancies were identified for melanoma and UADT cancers, where no significant association was found, and for head and neck cancer, which showed inconsistent effects.

Discussion

This systematic review and dose-response meta-analyses provided the first comprehensive summary of the associations between three major cancer prevention guidelines (the 2018 WCRF/AICR, the 2007 WCRF/AICR, and the 2012 ACS) with multiple cancer risk. We reported that adherence to cancer prevention guidelines confered significant protection against multiple cancers; however no significant associations were identified for prostate or ovarian cancers.

Regarding total cancer risk, Malcomson et al. reported a 27% risk reduction associated with greater adherence to the 2018 WCRF/AICR compared to lower adherence.[16] Consistently, our meta-analysis found a significant 14% reduction in total cancer risk among individuals adhering to cancer prevention guidelines. Specifically, risk reductions were 13% for adherence to the 2018 WCRF/AICR, 20% for the 2007 WCRF/AICR, and 14% for the 2012 ACS.

Concerning gastrointestinal cancers, our findings demonstrate a protective effect, particularly for colocteral cancer, which aligns with prior systematic reviews by Solans et al. and Malcomson et al. highlighting the benefits of both the 2007 and the 2018 WCRF/AICR guidelines.[15,16] Supporting this, our analysis incorporated 21 cohort studies (10 studies on the 2018 WCRF/AICR, 6 studies on the 2007 WCRF/AICR, 5 studies on the 2012 ACS), confirming that adherence to any of these guidelines significantly reduced colocteral cancer risk. Notably, our meta-analysis revealed a distinct protective pattern specific to stomach cancer. While adherence to cancer prevention guidelines showed broad protective effects against multiple malignancies, a significant inverse association with stomach cancer risk in categorical meta-analyses was observed only for the 2007 WCRF/AICR. In contrast, dose–response meta-analyses demonstrated significant risk reduction

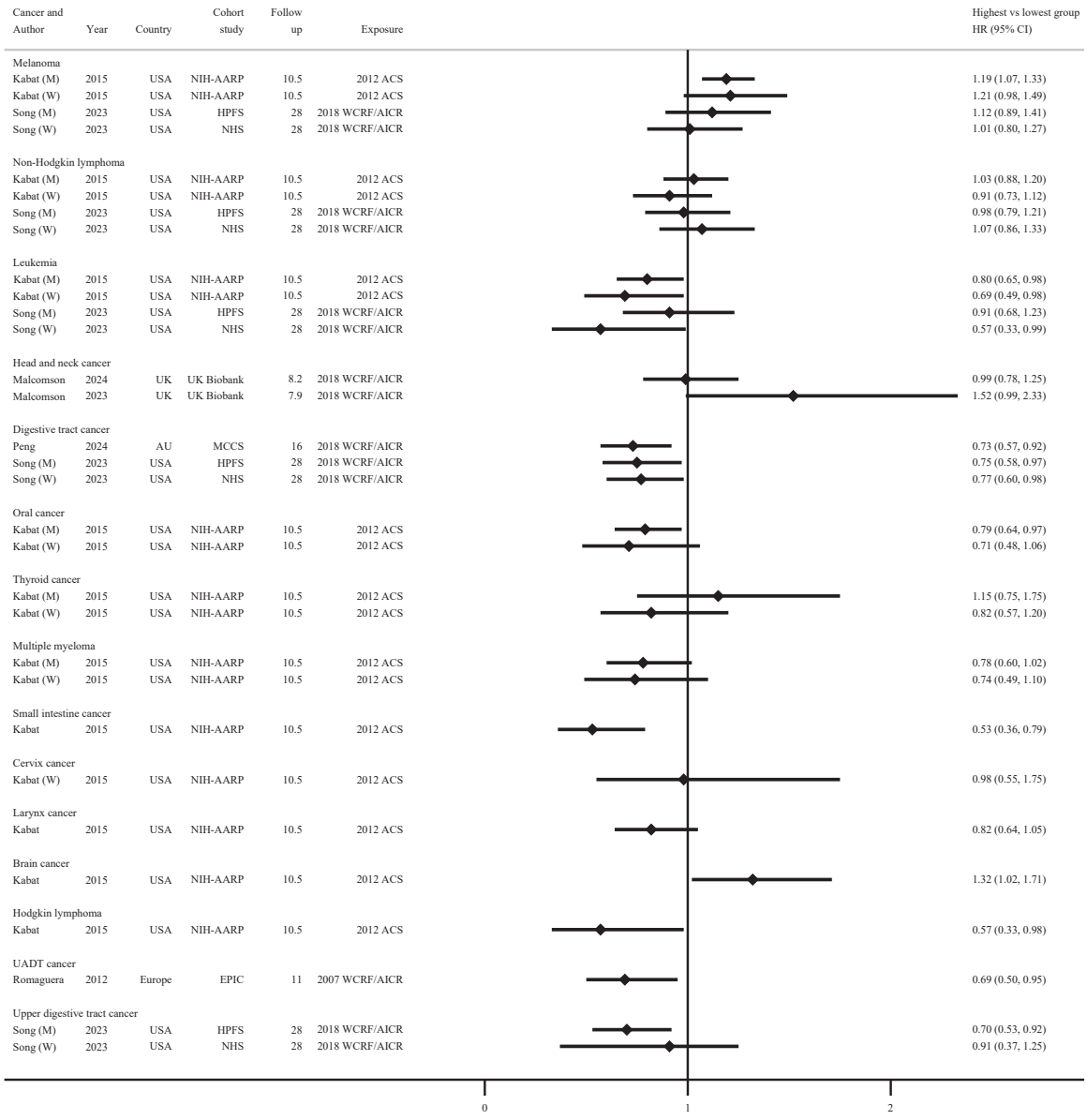

Fig. 2: Pooled hazard ratio (HR) and 95% confidence interval (CI) for the associations of adherence to cancer prevention guidelines with other cancers risk (n ≤ 2). UADT cancers, upper aerodigestive tract cancers.

for both the 2007 and 2018 WCRF/AICR per 1-point increase in adherence score. This discrepancy for the 2018 WCRF/AICR may stem from methodological differences. The categorical meta-analysis, which compares extreme adherence categories, can be influenced by varying definitions of adherence across studies, potentially diluting effect estimates. Conversely, the dose-response meta-anlaysis utilizes the full continuum of adherence data, offering greater statistical power to detect linear trends, particularly when the protective effect is distributed across the adherence spectrum rather than concentrated only in the highest category. Future studies should standardize adherence assessment methods and include more diverse populations to improve generalizability and better understand how dietary patterns and cultural contexts influence stomach cancer prevention. Regarding esophageal cancer, our findings are consistent with a 2021 systematic review,[45] which concluded that prevention was not attributable to any single food but rather to adherence

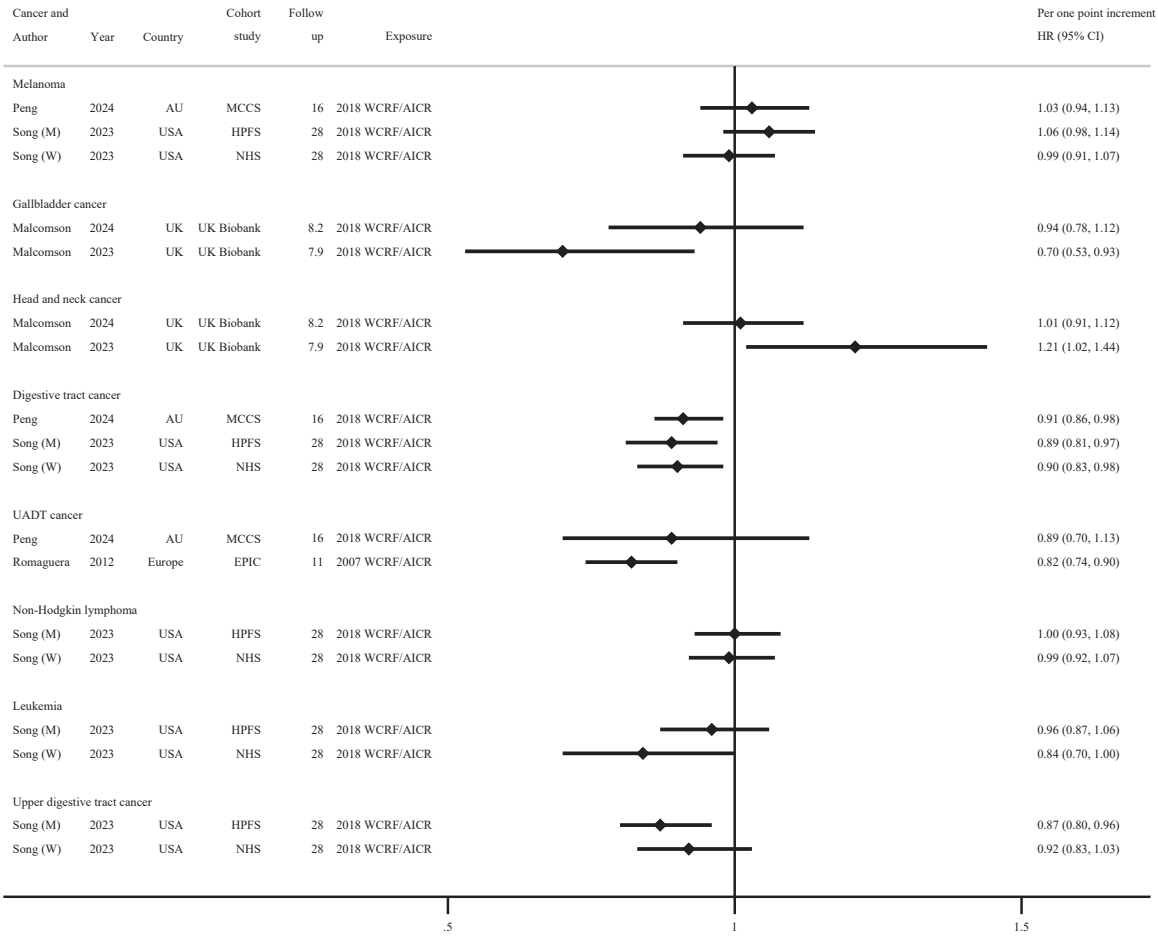

Fig. 3: Pooled hazard ratio (HR) and 95% confidence interval (CI) for the dose-response associations of adherence to cancer prevention guidelines with other cancers risk (n ≤ 2). UADT cancers, upper aerodigestive tract cancers.

to a multidimensional lifestyle pattern encompassing both dietary and non-dietary factors.

Adherence to cancer prevention guidelines was associated with a lower risk of most female hormone-related cancers (eg. breast cancer and uterus cancer), though no significant association was observed for ovarian cancer, findings were consistent with previous review.[15,16,46,47] Null association for ovarian cancer may stem from methodological limitations, including a limited number of available studies and relatively short follow-up durations, which reduce statistical power to detect a modest effect. Biologically, ovarian cancer comprises etiologically diverse subtypes (e.g., high-grade serous, endometrioid, and clear cell carcinomas), each with distinct risk profiles. Dominant influences such as genetic predisposition (e.g., BRCA mutations), reproductive history, and inflammatory pathways likely play a more substantial role in ovarian carcinogenesis, potentially overshadowing the modest effects of dietary and lifestyle factors.[48,49] With respect to breast cancer, our findings of a protective association; however, when stratified by menopausal status, our analysis revealed that the invers associations of the 2007 and the 2018 WCRF/AICR guidelines were significant only for postmenopausal breast cancer. This contrasts with the findings of Solans et al. and Malcomson et al.,[15,16] which reported risk reductions for breast cancer irrespective of menopausal status. We attributed this discrepancy primarily to limited statistical power in subgroup analyses and methodological differences. First, the number of premenopausal breast cancer cases available across the included cohorts was substantially smaller than that of postmenopausal cases, resulting in wider confidence intervals and reduced power to detect a significant association. Second, our meta-analysis exclusively included prospective cohort studies, in which exposure was measured before the outcome, thereby minimizing recall bias and strengthening temporal inference. In contrast, earlier reviews incorporated case-control and cross-sectional

studies, which were inherently more susceptible to recall bias.

Turning to genitourinary cancers, our findings align with previous reviews in showing no significant association between guideline adherence and prostate cancer risk.[15,16,47] Although one French cohort study using 24-h recall and a 3-year follow-up reported a protective association with adherence to the 2007 WCRF/AICR guidelines,[34] the remaining eight studies showed no significant effect. This overall null effect may reflect the distinct etiology of prostate cancer, including hormonal influences, genetic susceptibility, and racial disparities, which are not fully captured by lifestyle-based recommendations.[36,41] Novel meta-analytic evidence from this study indicated that adherence significantly reduced kidney cancer risk across all three guidelines, while for bladder cancer, a protective effect was observed only for the 2012 ACS guidelines.

Regarding digestive accessory organ (pancreas, liver, gallbladder) and respiratory (lung) cancers, our study consistently found protective effects. The lung cancer findings were consistent with prior literature.[15,16] For pancreatic cancer, our findings indicated that the inverse association of adherence to cancer prevention guidelines was observed only for the 2018 WCRF/AICR guidelines. Given that only one review had examined this association, and no meta-analysis had been conducted, our study provided the first comprehensive evidence supporting a protective effect of the 2018 WCRF/AICR on pancreatic cancer risk.[16] Furthermore, our null findings regarding the 2007 WCRF/AICR were consistent with the earlier review by Solans et al.[15] Furthermore, this is the first meta-analysis to demonstrate protective effects against liver cancer (associated with the 2018 WCRF/AICR and the 2012 ACS) and gallbladder cancer (associated with the 2012 ACS); however, these findings should be interpreted cautiously due to the limited number of primary studies available.

Regarding obesity-related cancers, our analysis supported a consistent protective effect across all three guidelines in the categorical meta-analysis. This overall effect appeared primarily driven by robust inverse associations for breast and colorectal cancers, However, a notable discrepancy emerged in the dose-response meta-analyses specifically for the 2007 WCRF/AICR, which did not show a significant association per 1-point increment in adherence score. Several methodological factors may explain this inconsistency: First, the limited number of studies available for the 2007 guidelines in the dose-response analysis likely reduced statistical power to detect a linear trend. Second, the non-linear nature of the relationship may play a key role: the protective effect might be observable only beyond a certain threshold of adherence, which is effectively captured by comparing extreme categories in the categorical analysis but not by a linear dose-response model that assumes uniform risk reduction across all adherence levels. Third, heterogeneity in scoring methods across primary studies may have introduced greater variability in continuous adherence assessments, further obscuring a significant dose-response relationship. Future research with larger datasets and standardized adherence measures is warranted to clarify the shape of this relationship and better account for cancer-specific etiological heterogeneity.

Among the 15 additional cancer types, consistent inverse associations were observed for digestive tract cancers, small intestine cancer, Hodgkin lymphoma, and UADT cancers, supporting a potential protective role of higher adherence to cancer prevention guidelines. No significant associations were found for non-Hodgkin lymphoma, head and neck cancer, thyroid cancer, multiple myeloma, cervical cancer, or laryngeal cancer, while results for melanoma, leukemia, oral cancer, and upper digestive tract cancers remained inconsistent. Of note, one study reported a positive association with brain cancer, but this finding should be interpreted cautiously given the very low incidence (732 cases among 476,396 participants), which increases the likelihood of chance associations. Dose-response analyses generally corroborated categorical results, though discrepancies for melanoma, UADT, and head and neck cancers suggested that methodological differences and limited statistical power may affect estimates. Taken together, the evidence remained heterogeneous, underscoring the need for large-scale studies with standardized adherence assessments.

The present review had several strengths, encompassing a comprehensive search strategy, inclusion of prospective cohort studies to minimize recall and selection biases inherent in case-control designs, and comprehensive evaluation of multiple distinct cancer outcomes representing the broadest comparative assessment of guideline adherence to date. Specifically, addressing the inherent limitations of the existing evidence base, our study systematically collated the three major cancer prevention guidelines and incorporated a large amount of recently published data while comprehensively integrating all previously investigated cancer types within the literature. The marked expansion in both the number of cohort studies and the cumulative cohort sample size, coupled with enhanced overall study quality, has enabled our analysis to prioritize evidence from cohort studies, widely regarded as the optimal source for causal inference in cancer prevention research. This methodological refinement, combined with the broader scope of our evidence synthesis, not only strengthens the focus on high-quality data but also substantially bolsters confidence in the accumulating evidence base. However, interpretation of our findings also requires consideration of limitations. Foremost, data scarcity precluding quantitative analysis for 16 cancer outcomes due to insufficient studies

(n < 3), highlighting critical evidence gaps demanding more site-specific cancer epidemiological research. Moreover, interpretation of composite cancer outcomes (eg. total cancer, obesity-related cancers) requires caution given differential etiologies across constituent cancer. Third, the assessment of risk reductions across multiple cancer outcomes was conducted without a statistical adjustment for multiple comparisons. While this exploratory approach enhances the sensitivity to identify potential associations, it concomitantly increases the probability of type I errors. Therefore, the results for individual cancer types, particularly those with borderline significance, should be interpreted with caution and require validation in future, hypothesis-confirming studies. Additionally, this review included only a single East Asian cohort (South Korea). The predominantly Western composition of the participants limits the generalizability of the findings to non-Western populations, particularly underscoring the need for future research in diverse Asian populations. Substantial methodological heterogeneity emerged from variability in guideline operationalization across studies, particularly in adherence scoring methodologies, threshold definitions, and the assessment tool of diet. Although a standardized scoring system existed for the 2018 WCRF/AICR guideline, its application in practice was not entirely consistent. These variations limited the direct comparability of effect estimates. To address this, we implemented dose-response meta-analyses modeling adherence to cancer prevention guidelines as a continuous exposure, and further assessed the associations by different cancer prevention guidelines and assessment tool of diet, although some residual variability may remain. Lastly, there was the temporal heterogeneity across studies. Although subgroup analyses by follow-up duration showed consistent results, residual heterogeneity may influence the precision of pooled risk estimates for specific cancer types. In conclusion, this systematic review and meta-analysis provided comprehensive evidence that adherence to cancer prevention guidelines was associated with reduced risks of multiple cancer types, while no significant associations were observed for prostate and ovarian cancers. These findings supported the integration of cancer prevention guidelines into public health practice as a strategy to reduce the incidence of multiple cancers. Further high-quality, large-scale prospective studies are warranted to confirm the protective effects of the 2018 WCRF/AICR on less commonly studied cancers and across diverse populations, particularly among Asian populations.

Contributors

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Data sharing statement

The data and analytic code that support the findings of this study are available on request from the corresponding author.

Declaration of interests

No potential conflicts of interest relevant to declare.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.eclinm.2025.103569.

References

1 Ferlay J, Ervik M, Lam F, et al. *Global cancer observatory: cancer today*. Lyon: International agency for research on cancer; 2020: 20182020.
2 Armenta-Guirado BI, González-Rocha A, Mérida-Ortega Á, et al. Lifestyle quality indices and female breast cancer risk: a systematic review and meta-analysis. *Adv Nutr*. 2023;14(4):685–709.
3 Jiang X, Pestoni G, Vinci L, et al. Cancer cases attributable to modifiable lifestyle risk factors in Switzerland between 2015 and 2019. *Int J Cancer*. 2024;154(7):1221–1234.
4 Clinton SK, Giovannucci EL, Hursting SD. The world cancer research Fund/American institute for cancer research third expert report on diet, nutrition, physical activity, and cancer: impact and future directions. *J Nutrition*. 2020;150(4):663–671.
5 Lazcano-Ponce E. Second expert report, food, nutrition, physical activity and the prevention of cancer: a global perspective. *Salud Publica Mex*. 2009;51:S678–S680.
6 Organization WH. *Time to deliver: report of the WHO independent high-level commission on noncommunicable diseases. Time to deliver: report of the WHO Independent high-level commission on non-communicable diseases*. 2018.
7 WCRF/AICR. *Diet, nutrition, physical activity and cancer: a global perspective*. 2018.
8 Shams-White MM, Brockton NT, Mitrou P, et al. Operationalizing the 2018 world cancer research Fund/American Institute for cancer research (WCRF/AICR) cancer prevention recommendations: a standardized scoring system. *Nutrients*. 2019;11(7):1572.
9 Kushi LH, Byers T, Doyle C, et al. American cancer society guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin*. 2006;56(5):254–281.
10 Kushi LH, Doyle C, McCullough M, et al. American cancer society guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin*. 2012;62(1):30–67.
11 Malcomson FC, Parra-Soto S, Ho FK, et al. Adherence to the 2018 World Cancer Research Fund (WCRF)/American Institute for Cancer Research (AICR) cancer prevention recommendations and risk of 14 lifestyle-related cancers in the UK biobank prospective cohort study. *BMC Med*. 2023;21(1):407.
12 Peng Y, Bassett JK, Hodge AM, et al. Adherence to 2018 WCRF/AICR cancer prevention recommendations and risk of cancer: the Melbourne collaborative cohort study. *Cancer Epidemiol Biomarkers Prev*. 2024;33(1):43–54.
13 Xu J-Y, Vena JE, Whelan HK, et al. Impact of adherence to cancer-specific prevention recommendations on subsequent risk of cancer in participants in Alberta's tomorrow project. *Public Health Nutr*. 2019;22(2):235–245.
14 Petimar J, Smith-Warner SA, Rosner B, et al. Adherence to the world cancer research fund/American Institute for Cancer Research 2018 recommendations for cancer prevention and risk of colorectal cancer. *Cancer Epidemiol Biomarkers Prev*. 2019;28(9):1469–1479.

15 Solans M, Chan D, Mitrou P, et al. A systematic review and meta-analysis of the 2007 WCRF/AICR score in relation to cancer-related health outcomes. *Ann Oncol*. 2020;31(3):352–368.
16 Malcomson FC, Wiggins C, Parra-Soto S, et al. Adherence to the 2018 world cancer research fund/American Institute for Cancer Research Cancer prevention recommendations and cancer risk: a systematic review and meta-analysis. *Cancer*. 2023;129(17):2655–2670.
17 Stroup DF, Berlin JA, Morton SC, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. *J Am Med Assoc*. 2000;283(15):2008–2012.
18 Wells GA, Shea B, O'Connell D, et al. *The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses*. 2000.
19 DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7(3):177–188.
20 Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med*. 2002;21(11):1539–1558.
21 Nomura SJO, Inoue-Choi M, Lazovich D, et al. WCRF/AICR recommendation adherence and breast cancer incidence among postmenopausal women with and without non-modifiable risk factors. *Int J Cancer*. 2016;138(11):2602–2615.
22 Hastert TA, White E. Association between meeting the WCRF/AICR cancer prevention recommendations and colorectal cancer incidence: results from the VITAL cohort. *Cancer Causes Control*. 2016;27(11):1347–1359.
23 Andersen SW, Blot WJ, Shu XO, et al. Adherence to cancer prevention guidelines and cancer risk in low-income and African American populations. *Cancer Epidemiol Biomarkers Prev*. 2016;25(5):846–853.
24 Barrios-Rodríguez R, Toledo E, Martinez-Gonzalez MA, et al. Adherence to the 2018 world cancer research fund/american institute for cancer research recommendations and breast cancer in the sun project. *Nutrients*. 2020;12(7):1–12.
25 Barrubés L, Babio N, Hernández-Alonso P, et al. Association between the 2018 WCRF/AICR and the low-risk lifestyle scores with colorectal cancer risk in the predimed study. *J Clin Med*. 2020;9(4):1215.
26 Catsburg C, Miller AB, Rohan TE. Adherence to cancer prevention guidelines and risk of breast cancer. *Int J Cancer*. 2014;135(10):2444–2452.
27 Harris HR, Bergkvist L, Wolk A. Adherence to the World Cancer Research Fund/American Institute for Cancer Research recommendations and breast cancer risk. *Int J Cancer*. 2016;138(11):2657–2664.
28 Hastert TA, Beresford SAA, Patterson RE, et al. Adherence to WCRF/AICR cancer prevention recommendations and risk of postmenopausal breast cancer. *Cancer Epidemiol Biomarkers Preve*. 2013;22(9):1498–1508.
29 Jones P, Cade JE, Evans CEL, et al. Does adherence to the World Cancer Research Fund/American Institute of Cancer Research cancer prevention guidelines reduce risk of colorectal cancer in the UK Women's Cohort Study? *Br J Nutr*. 2018;119(3):340–348.
30 Kabat GC, Matthews CE, Kamensky V, et al. Adherence to cancer prevention guidelines and cancer incidence, cancer mortality, and total mortality: a prospective cohort study. *Am J Clin Nutr*. 2015;101(3):558–569.
31 Kaluza J, Harris HR, Håkansson N, et al. Adherence to the WCRF/AICR 2018 recommendations for cancer prevention and risk of cancer: prospective cohort studies of men and women. *Br J Cancer*. 2020;122(10):1562–1570.
32 Karavasiloglou N, Husing A, Masala G, et al. Adherence to the World Cancer Research Fund/American Institute for Cancer Research cancer prevention recommendations and risk of in situ breast cancer in the European Prospective Investigation into Cancer and Nutrition (EPIC) cohort. *BMC Med*. 2019;17(1):11.
33 Karavasiloglou N, Pestoni G, Kuhn T, et al. Adherence to cancer prevention recommendations and risk of breast cancer in situ in the United Kingdom Biobank. *Int J Cancer*. 2022;151(10):1674–1683.
34 Lavalette C, Adjibade M, Srour B, et al. Cancer-specific and general nutritional scores and cancer risk: results from the prospective NutriNet-Sante cohort. *Cancer Res*. 2018;78(15):4427–4435.
35 Lee J, Shin A, Shin WK, et al. Adherence to the World Cancer Research Fund/American Institute for Cancer Research and Korean Cancer Prevention Guidelines and cancer risk: a prospective cohort study from the health examinees-gem study. *Epidemiol Health*. 2023;45:e2023070.
36 Makarem N, Lin Y, Bandera EV, et al. Concordance with World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) guidelines for cancer prevention and obesity-related cancer risk in the Framingham Offspring cohort (1991–2008). *Cancer Causes Control*. 2015;26(2):277–286.
37 Malcomson FC, Parra-Soto S, Ho FK, et al. Abbreviated Score to assess adherence to the 2018 WCRF/AICR cancer prevention recommendations and risk of cancer in the UK biobank. *Cancer Epidemiol Biomarkers Prev*. 2024;33(1):33–42.
38 Nomura SJO, Dash C, Rosenberg L, et al. Adherence to diet, physical activity and body weight recommendations and breast cancer incidence in the Black Women's Health Study. *Int J Cancer*. 2016;139(12):2738–2752.
39 Nomura SJO, Dash C, Rosenberg L, et al. Is adherence to diet, physical activity, and body weight cancer prevention recommendations associated with colorectal cancer incidence in African American women? *Cancer Causes and Control*. 2016;27(7):869–879.
40 Onyeaghala G, Lintelmann AK, Joshu CE, et al. Adherence to the World Cancer Research Fund/American Institute for Cancer Research cancer prevention guidelines and colorectal cancer incidence among African Americans and whites: the Atherosclerosis Risk in Communities study. *Cancer*. 2020;126(5):1041–1050.
41 Pichardo MS, Irwin ML, Esserman D, et al. A competing risk analysis of adherence to the American Cancer Society Guidelines on Nutrition and Physical Activity for Cancer Prevention and obesity-related cancer risk in Hispanic/Latino adults in the NIH-AARP Diet and Health Study. *Int J Cancer*. 2022;151(11):1902–1912.
42 Song R, Riseberg E, Petimar J, et al. Different operationalizations of the 2018 WCRF/AICR cancer prevention recommendations and risk of cancer. *Br J Cancer*. 2023;129(6):982–992.
43 Romaguera D, Vergnaud AC, Peeters PH, et al. Is concordance with World Cancer Research Fund/American Institute for Cancer Research guidelines for cancer prevention related to subsequent risk of cancer? Results from the EPIC study. *Am J Clin Nutr*. 2012;96(1):150–163.
44 Zhang ZQ, Li QJ, Hao FB, et al. Adherence to the 2018 World Cancer Research Fund/American Institute for Cancer Research cancer prevention recommendations and pancreatic cancer incidence and mortality: a prospective cohort study. *Cancer Med*. 2020;9(18):6843–6853.
45 Nucci D, Marino A, Realdon S, et al. Lifestyle, WCRF/AICR recommendations, and esophageal adenocarcinoma risk: a systematic review of the literature. *Nutrients*. 2021;13(10):3525.
46 Turati F, Dalmartello M, Bravi F, et al. Adherence to the World Cancer Research Fund/American Institute for Cancer Research recommendations and the risk of breast cancer. *Nutrients*. 2020;12(3):607.
47 Kohler LN, Garcia DO, Harris RB, et al. Adherence to diet and Physical Activity Cancer Prevention Guidelines and cancer outcomes: a systematic review. *Cancer Epidemiol Biomarkers Prev*. 2016;25(7):1018–1028.
48 Webb PM, Jordan SJ. Epidemiology of epithelial ovarian cancer. *Best Pract Res Clin Obstet Gynaecol*. 2017;41:3–14.
49 Lisio MA, Fu L, Goyeneche A, et al. High-Grade serous ovarian cancer: basic sciences, clinical and therapeutic standpoints. *Int J Mol Sci*. 2019;20(4):952.