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The relationship between coffee consumption and the risk of gastric cancer; a systematic review and meta-analysis

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Abstract

Introduction: Stomach cancer is among five common malignancies whose prevalence and incidence are considerably associated with our dietary regime. Thus, the present study aims to conduct a systematic review and meta-analysis to evaluate the relationship between coffee drinking and the risk of stomach cancer.
Materials and Methods: A comprehensive literature search of the databases, including Barakat Knowledge Network System, Cochrane, IranDoc, Web of Science, PubMed, SID, Magiran, Scopus, and Google Scholar web browser was conducted using standard keywords. Data analysis of this meta-analysis was conducted using STATA 14 software and P<0.05 was considered as a significant level for tests.
Results: A total of 24 studies with a sample size of 990605 were reviewed which showed drinking coffee prevents stomach cancer [OR=0.89, (95% CI: 0.82, 0.98]. However, subgroup analysis by gender found no significant statistical relationship between coffee consumption and stomach cancer risk regarding male or female gender. However, the statistically significant relationship between coffee drinking and stomach cancer risk was assessed in several countries, including Korea, Turkey, Uruguay, Venezuela, and Singapore, with the largest effect being reported in Turkey [OR=0.51 (95% CI: 0.39,0.67].
Conclusion: Coffee consumption prevents and reduces the risk of developing stomach cancer.

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Introduction

According to GLOBOCAN 2018, gastric cancer is the third leading cause of cancer death worldwide after lung and colorectal cancer. Gastric cancer is the fifth most common cancer of all, with more than one million new cases diagnosed worldwide each year (1,2). Male gender, smoking, and higher-than-normal body mass index (BMI) are risk factors for gastric cancer (3,4). According to the World Health Organization (WHO), the increase in the number of elderly people in the world will lead to an increase of almost 50% in new cases of cancer in the next 20 years. On the other hand, it is reported that about one third of common cancers, including liver, lung, breast, and stomach cancers, are preventable, and diet is one of the methods of prevention (5,6).

Coffee is the second largest beverage in the world (7). In 1991, the working group of International Agency for Research on Cancer evaluated coffee as a potential carcinogen for humans (8). For years, the relationship between coffee consumption and its impact on gastric cancer risk has been controversial (9,10). Concerning the variations observed in the previous studies, the current study attempts to address the relationship between coffee consumption and stomach cancer risk

Key point

A total of 24 studies with a sample size of 990 605 were reviewed which showed drinking coffee prevents gastric cancer [OR=0.89, (95%CI (0.82, 0.98)]. However, subgroup analysis by gender found no significant statistical relationship between coffee drinking and gastric cancer risk regarding male or female gender. However, the statistically significant relationship between coffee drinking and gastric cancer risk was assessed in several countries, including Korea, Turkey, Uruguay, Venezuela, and Singapore, with the largest effect being reported in Turkey.

using a systematic review and meta-analysis approach.

Materials and Methods

Study design

This meta-analysis study examines the association between coffee consumption and gastric cancer risk. The review is carried out based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for systematic review and meta-analysis studies. The protocol of this meta-analysis was registered on the site of PROSPERO (#CRD42022316450).

Studies outcomes

The primary outcome: The association between coffee consumption and gastric cancer.

Search strategy

In this meta-analysis, the Iranian databases, including Barakat Knowledge Network System, SID, Magiran, and IranDoc, along with international databases including Cochrane, Web of Science, PubMed, Scopus, and Google Scholar web browser, were searched without time or language restrictions. For papers published in languages other than Persian or English, the full article was translated to extract its data. The search strategy step was performed by standard keywords and, including "Coffee," "Cancer," "Neoplasm,", and "Stomach," as well as their Persian equivalents (updated until Jan 2, 2022). Keyword combinations using Boolean operators "AND" and "OR" were also included in the database search. Additionally, the list of references of all primary studies that remained at the end of the PRISMA flowchart and entered the meta-analysis was screened by manual search.

The inclusion and exclusion criteria

PICO components

The studied population: Coffee consumers, *Intervention:* Coffee consumption, *Comparison:* Those who do not drink coffee, *the studied outcomes:* The risk of developing gastric cancer.

The inclusion criteria

This meta-analysis included cross-sectional, cohort, and case-control studies that explored the effect of coffee consumption on stomach cancer risk. The intervention group was coffee consumers, and the comparison or control group was the non-intervention status. The eligible studies must have evaluated the relationship between coffee consumption and stomach cancer.

The exclusion criteria

Studies that only qualitatively described the coffee effect on gastric cancer; Low-quality studies evaluated using a quality assessment checklist based on the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement; case-report or case series studies; lack of reporting of the required information for data analysis; studies that examined the effect of coffee consumption on other cancers such as the esophagus or oral cancers; unavailability of the full-text of articles; and studies that have evaluated the impact of other beverages like green and black tea on gastric cancer.

Qualitative assessment of studies

The two researchers independently assessed quality from different perspectives using the STROBE checklist (11). The STROBE checklist has 22 sections that cover different sections of a report. In this checklist, the sum of the scores is decisive, therefore a score of 1-15 indicates low quality, 16-30 indicates average quality and 31-44 indicates excellent quality. The cut-off point in this study was 15 points.

Data extraction

Two researchers extracted data from studies independently to minimize the biased reporting and error in data collecting. They entered the extracted data into a checklist containing the study title, researcher name, year of publication, sample size, coffee consumption dose and duration, study type, the sizes of case and control groups, the location of study, odds ratio (OR) between coffee consumption and stomach cancer risk and its upper and lower limits. A third researcher evaluated the data extracted by the two previous researchers to correct any existing discrepancies.

Statistical analysis

To examine the relationship between coffee consumption and gastric cancer risk was applied OR. The logarithm of OR was taken in each study to combine the studies' results. The heterogeneity of the studies was assessed using the I^2 index and Q-Cochrane test. The random-effects model was used in this work to combine the reviewed studies (I^2=53.9%). Data analysis was executed using STATA 14 software. The significance level was considered P<0.05 for all tests. Meta-regression was employed to evaluate the relationship between "coffee consumption and gastric cancer risk" and "sample size" and "year of publication."

Results

Study selection process

Initially, 415 articles were found in the search in the mentioned databases. After checking the studies' titles, 195 duplicate studies were excluded. The abstracts of 220 articles were explored, and 51 articles whose full texts were not available were excluded. The full texts of the 169 remaining papers were screened, and another 145 articles that met the other exclusion criteria were discarded. Eventually, 24 high-quality articles entered the meta-analysis process (Figure 1).

The specifications of the reviewed articles are given in Table 1.

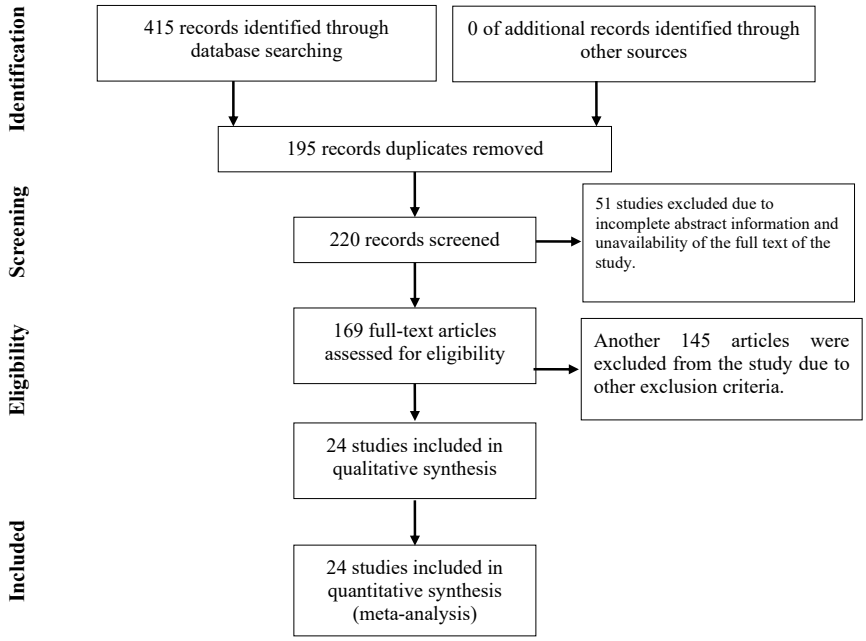

Figure 1. The process of entering the studies into the systematic review and meta-analysis.

A summary of background information for the reviewed studies

We reviewed a total of 24 articles, including 14 case-control studies, 19 cohorts, and one cross-sectional study published from 1990 to 2021 with a number of samples of 990 605 people (15 865 case and 97 4740 control). The dose and duration of coffee consumption differed in the reviewed studies. However, we could not homogenize them due to the different measurement units used among these studies (Table 1).

Evaluation of the primary outcome

Generally, drinking coffee prevents stomach cancer [0.89 (95% CI : 08.2-0.98)] (Figure 2).

Evaluation of the secondary outcomes

In the subgroup analysis by study type, we observed no statistically significant association between drinking coffee and gastric cancer risk in case-control and cohort studies. However, in the cross-sectional study, drinking coffee significantly reduced the risk of stomach cancer.

In an analysis by gender, no statistically significant relationship was noted between drinking coffee and gastric cancer risk regarding male or female gender. Thus, our study does not support gender as a risk factor for stomach cancer incidence (Table 2).

In the analysis by country, statistically significant associations between drinking coffee and gastric cancer risk were reported in Korea, Turkey, Uruguay, Venezuela, and Singapore. Among them, the highest effect was found in a Turkish study which revealed that drinking coffee remarkably reduces the risk of gastric cancer in Turkey [OR = 0.51 (95% CI: 0.39-0.67)] (Table 2).

Additional analysis

As shown in Figure 3, meta-regression identified no statistically significant relationship between "the effect of coffee consumption on gastric cancer risk" and "publication year of the studies" ($P = 0.689$).

In Figure 4, meta-regression found no statistically significant association between "the effect of coffee consumption on gastric cancer risk" and "sample size" ($P = 0.312$). This finding indicates that even in studies with larger samples, drinking coffee was not considered more effective in preventing gastric cancer.

Discussion

This study states that drinking coffee prevents and reduces the risk of developing stomach cancer. A meta-analysis by Xie et al in 2016, including 7631 cases and 1019693 controls, showed that hazard ratio for stomach cancer was 0.94 (95% CI: 0.88-0.99) for the highest level of coffee consumption compared to the lowest level. Similarly, the hazard ratio was 0.93 (95% CI: 0.88-0.99) for coffee consumers versus abstainers. The pooled risk ratio (RR) for the populations with coffee consumption of less than 1 cup per day 0.95, 1-2 cups per day 0.92, and 3-4 cups per day 0.88 were, compared to those who did not drink coffee. There was a significant relationship between coffee consumption and a decrease in risk of stomach cancer in the case-control studies (RR = 0.85, 95% CI: 0.77-0.95) (36). The results of this meta-analysis corroborate the result of our present meta-analysis. Given that the former meta-analysis was published in 2016 and has not covered the studies published afterward (from 2016 to 2022), thus the current study provides a more comprehensive meta-analysis by including larger sample size and providing

Table 1. Specifications of articles, which entered into the meta-analysis process

First author, Year of publication	Country	Type of study	No. of cases	No. of controls	Coffee consumption	OR	Low OR	Up OR	Adjustments
Lee HH, 1990 (12)	Taiwan	Hospital-based case-control	210	810	Drinker vs non-drinker	1.41	0.72	2.75	Age and sex
Agudo A, 1992 (13)	Spain	Hospital-based case-control	228	227	Drinker vs non-drinker	0.97	0.67	1.4	Age, sex, area of residence, total calories, fruits, vegetables, preserved fish, etc
Memik F, 1992 (14)	Turkey	Case-control	79	608	2～3 Cups/d vs £1 Cup/d	0.96	0.18	3.28	Age
Hoshiyama Y, 1992 (15)	Japan	Population-based case-control	251	483	≥10 Cups/wk vs £1 Cup/w	0.9	0.6	1.4	Age, smoking, dietary items including salty foods, fruits, vegetables, seaweed, boiled fish, etc
Hansson LE, 1993 (16)	Sweden	Population-based case-control	338	669	≥3100 mL/wk vs none	1.07	0.72	1.59	Age, sex, socio-economic status (SES), fruits, vegetables, etc
Stensvold I, 1994 (17)	Norway	Cohort	151	42973	≥7 Cups/d vs £2 cup/d	0.58	0.29	1.17	Age, smoking, residence
Ji BT, 1996 (35)	Shanghai, China	Population-based case-control	1123	1249	Drinker vs non-drinker	0.73	0.42	1.27	Age, sex
Inoue M, 1998 (18)	Japan	Hospital-based case-control	893	21128	≥3 Cups/d vs rarely	0.93	0.72	1.21	Age, sex, smoking, alcohol intake, tea, rice, fruit, beef
Galanis DJ, 1998 (19)	Japanese in Hawaii	Cohort	108	11907	≥2 Cups/d vs none	1.8	1	3.3	Age, education, place of birth, smoking, alcohol.
Chow WH, 1999 (20)	Poland	Population-based case-control	476	480	≥7 Cups/wk vs none	1.23	0.8	1.89	Age, smoking, education, family history of cancer
Munoz N, 2001 (21)	Venezuela	Population-based case-control	292	485	Quartiles	0.58	0.37	0.92	Age, sex, smoking, alcohol intake, total energy intake, SES.
Tsubono Y, 2001 (22)	Japan	Cohort	419	199748	≥3 Cups/d vs none	1	0.6	1.6	Age, sex, tea, smoking, alcohol, rice, meat, vegetables, fruits, soup, etc
Rao DN, 2002 (23)	India	Hospital-based case-control	119	1577	Daily vs never/ rarely	1.2	0.3	3.5	Age, sex
De Stefani E, 2004 (24)	Uruguay	Hospital-based case-control	240	960	Tertiles	0.65	0.48	0.9	Age, smoking, alcohol intake, total energy intake, residence, education, BMI.
Khan MM, 2004 (25)	Japan	Cohort	51	3158	≥Several times/ wk vs ≤several times/m	0.77	0.42	1.42	Age, health status, health education, smoking
Larsson SC, 2006 (26)	Sweden	Cohort	160	61433	≥4 Cups/d vs £1 cups/d				Age, time period, education, alcohol, tea consumption
Gallus S, 2009 (27)	Italy	Population-based case-control	769	2081	≥4 cups/d vs none	1.24	0.94	1.65	Age, sex, education, BMI, residence, smoking, alcohol, fruits, vegetables.
Icli F, 2011 (28)	Turkey	Hospital-based case-control	253	253	≥1 cups/d vs none	0.5	0.4	0.7	Income, bread consumption, smoking, cooking oil, fish
Bidel S, 2013 (29)	Finland	Cohort	299	60041	≥10 cups/d vs none	0.75	0.4	1.41	Age, study year, education, smoking, alcohol, physical activity, diabetes, tea, BMI

Table 1. Continued

First author, Year of publication	Country	Type of study	No. of cases	No. of controls	Coffee consumption	OR	Low OR	Up OR	Adjustments
Ainslie-Waldman CE, 2014 (30)	Singapore	Cohort	647	63257	Daily vs non-daily	0.54	0.31	0.91	Age, sex, interview year, education, smoking, BMI, caffeine, total energy intake.
Sanikini H, 2015 (31)	France, Germany, Greece, Italy, Norway, Spain, Denmark, Sweden, The Netherlands and United Kingdom	Cohort	189	443195	557-4700 mL/day vs non-drinker	1.09	0.84	1.43	BMI, alcohol consumption, energy intake from fat and non-fat, vegetable intake, fruit intake, etc
Tran KT, 2019 (32)	UK	Cohort	99	184	>1-2 Cups/day vs non-drinker	0.88	0.59	1.3	Age, sex, deprivation, education, BMI, alcohol, smoking, fruit and vegetable intake, tea intake, physical activity, etc
Tran KT, 2019 (32)	UK	Cohort	55	184	3-4 Cups/day vs non-drinker	1.14	0.73	1.79	Age, sex, deprivation, education, BMI, alcohol, smoking, fruit and vegetable intake, tea intake, physical activity, etc
Tran KT, 2019 (32)	UK	Cohort	30	184	≥5 Cups/day vs non-drinker	1.18	0.7	1.98	Age, sex, deprivation, education, BMI, alcohol, smoking, fruit and vegetable intake, tea intake, physical activity, etc
Martimianaki G, 2021 (33)	Italy	Case-control	8198	21419	1-2 Cups/day vs never or rare drinkers	0.91	0.81	1.03	Sex, age and the main recognized risk factors for gastric cancer
Martimianaki G, 2021 (33)	Italy	Case-control	8198	21419	3-4 Cups/day vs never or rare drinkers	0.95	0.82	1.1	Sex, age and the main recognized risk factors for gastric cancer
Martimianaki G, 2021 (33)	Italy	Case-control	8198	21419	≥5 Cups/day vs never or rare drinkers	0.95	0.79	1.15	Sex, age and the main recognized risk factors for gastric cancer
Martimianaki G, 2021 (33)	Italy	Case-control	8198	21419	≥7 Cups/day vs never or rare drinkers	1.2	0.91	1.58	Sex, age and the main recognized risk factors for gastric cancer
Kim SY, 2021 (34)	Korea	Population-based Cross-Sectional	188	36047	1–30 cups/month vs non-drinker	0.71	0.58	0.86	Age, sex, income group, BMI, smoking, alcohol, hypertension, diabetes, hyperlipidemia, stroke, etc
Kim SY, 2021 (34)	Korea	Population-based Cross-Sectional	360	62446	30–60 cups/month vs non-drinker	0.82	0.69	0.98	Age, sex, income group, BMI, smoking, alcohol, hypertension, diabetes, hyperlipidemia, stroke, etc
Kim SY, 2021 (34)	Korea	Population-based Cross-Sectional	191	35857	>60 cups/month vs non-drinker	0.8	0.65	0.98	Age, sex, income group, BMI, smoking, alcohol, hypertension, diabetes, hyperlipidemia, stroke, etc

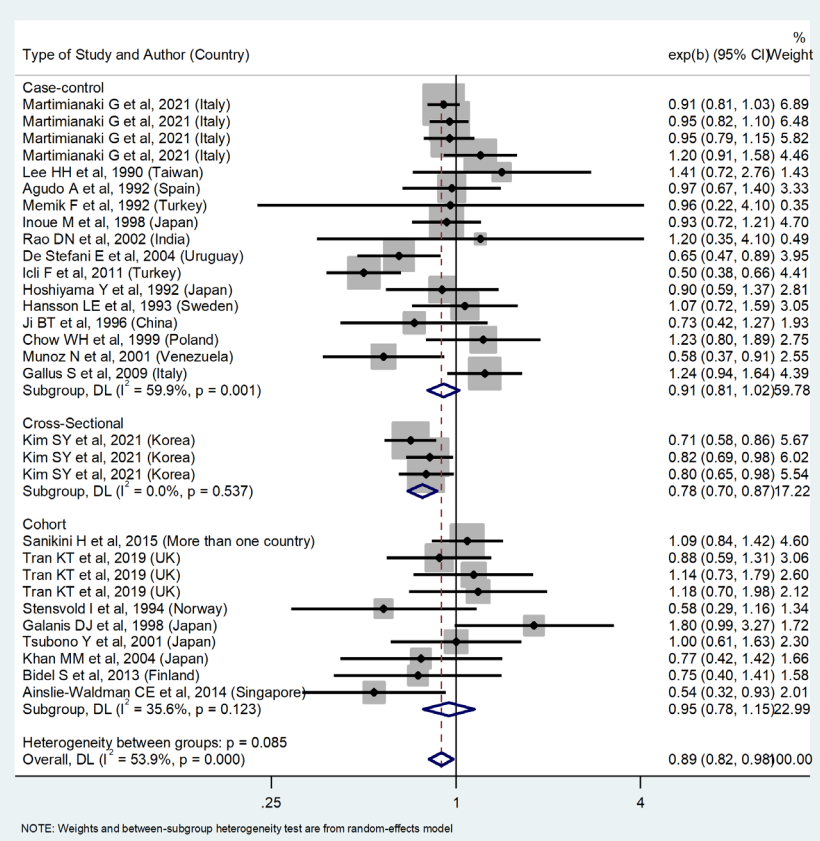

Figure 2. The plot of the relationship between drinking coffee and the risk of gastric cancer by country and publication year of the study.

more recent and up-to-date information. Therefore, this allows us to comment more confidently on the stomach cancer-protective effect of coffee.

A 2016 study by Deng et al, including 13 prospective studies, showed that excessive coffee consumption might increase the risk of developing stomach cancer. Furthermore, a notably elevated risk of cardia stomach cancer associated with coffee consumption was observed

Table 2. Exploring the effect of drinking coffee on gastric cancer risk in studied subgroups

	Subgroups	OR	Low-OR	UP-OR	*P* value	I^2(%)
Type of study	Case-control	0.91	0.81	1.02	0.001	59.9
	Cohort	0.95	0.78	1.15	0.123	35.6
	Cross sectional	0.78	0.70	0.87	0.537	0
Gender	Men	0.90	0.74	1.10	0.039	47.7
	Women	0.78	0.59	1.03	0.001	66.6
Country	Italy	0.99	0.89	1.10	0.170	37.7
	Korea	0.78	0.70	0.87	0.537	0
	UK	1.03	0.80	1.33	0.586	0
	Taiwan	1.41	0.72	2.76	---	---
	Spain	0.97	0.67	1.40	---	---
	Turkey	0.51	0.39	0.67	0.387	0
	Japan	0.99	0.80	1.22	0.297	18.4
	India	1.20	0.35	4.10	---	---
	Uruguay	0.65	0.47	0.89	---	---
	Sweden	1.07	0.72	1.59	---	---
	China	0.73	0.42	1.27	---	---
	Poland	1.23	0.80	1.89	---	---
	Venezuela	0.58	0.37	0.91	---	---
	Norway	0.58	0.29	1.16	---	---
	Finland	0.75	0.40	1.41	---	---
	Singapore	0.54	0.32	0.93	---	---

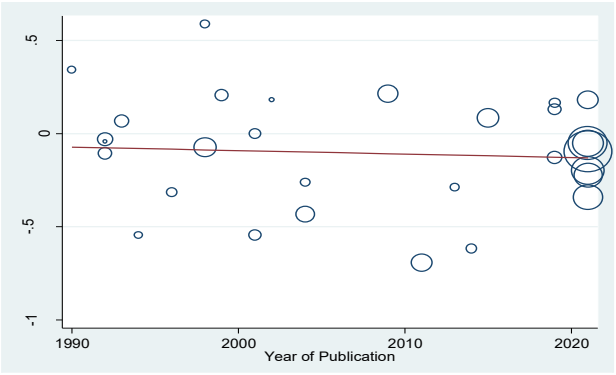

Figure 3. Meta-regression of the relationship between "the effect of coffee consumption on gastric cancer risk" and "year of publication."

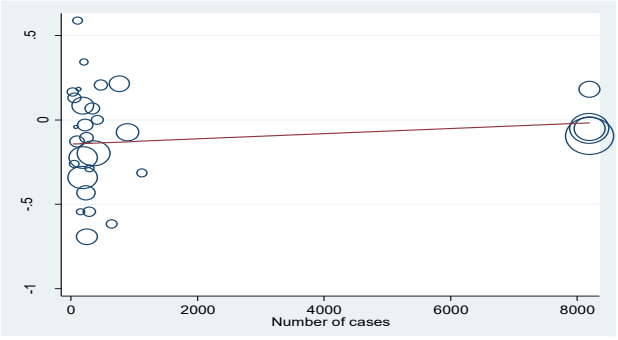

Figure 4. Meta-regression of the relationship between "the effect of coffee consumption on gastric cancer risk" and "sample size."

(RR: 1.50, 95% CI: 1.09-2.07) (37). Previous meta-analysis considered coffee drinking a risk factor for stomach cancer and concluded that the risk of developing stomach cancer increased in coffee drinkers, which contradicts the results of the present meta-analysis. This discrepancy in results may be explained because these studies concentrated solely on a particular type of study (cohort), whereas our meta-analysis has covered all case-control, cohort, and cross-sectional studies concurrently.

While the following meta-analysis showed that there is no statistically significant relationship between coffee consumption and stomach cancer, Li et al conducted a meta-analysis on 13 prospective cohort studies in 2015, with 20 independent reports, including 3368 patients with stomach cancer and 1372811 participants during a 4.3-8 year follow-up period. The results suggested that the pooled relative risk was 1.13 (95% CI: 0.94-1.35) in comparison to the lowest level of coffee consumption. The dose-response analysis showed that the relative risk of developing gastric cancer was 1.03 (95% CI: 0.95-1.11) for drinking three cups of coffee per day. Consequently, this meta-analysis does not confirm the hypothesis that coffee consumption is related to the risk of gastric cancer (10). The variations and inconsistencies in reporting among the previous meta-analysis studies motivated us to carry out a novel comprehensive study using a systematic review and meta-analysis approach to shed light on these discrepancies.

Conclusion

In the 24 reviewed studies from the last three decades, coffee consumption has a preventive effect on developing stomach cancer and is considered to serve as a preventative and protective factor against this disease. However, in the subgroup analysis by gender, there was no statistically significant relationship between coffee drinking and stomach cancer risk regarding the male or female gender.

Limitations of the study

It did not analyze the dose of coffee consumption because of the different measurement units of coffee drinking reported in various studies (such as cups and mL). Second, given the non-uniform distribution of studies in different countries, reporting was not possible for many countries due to the lack of information available about them. Furthermore, most reviewed studies failed to address the age group of subjects. Thus, we could not carry out a subgroup analysis of the results by age. The unavailability of the full text of some studies was another limitation of this study.

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Authors' contribution

Conceptualization: MF, MY. Methodology: MR, MM. Formal Analysis: MM. Resources: MR, HF, MY. Data Curation: MF, HF. Writing—Original Draft Preparation: All authors. Writing—Review and Editing: All authors. Project Administration: MF, HF. Funding Acquisition: MF.

Conflicts of interest

The authors declare that they have no conflict of interest regarding the contents of this article.

Ethical issues

Ethical issues (including plagiarism, data fabrication and double publication) have been completely observed by the authors.

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