World Journal of *Gastrointestinal Oncology*

World J Gastrointest Oncol 2021 May 15; 13(5): 312-461





Published by Baishideng Publishing Group Inc

World Journal of Gastrointestinal Oncology

Contents

Monthly Volume 13 Number 5 May 15, 2021

REVIEW

- 312 Hypoxia and its impact on the tumour microenvironment of gastroesophageal cancers King R, Hayes C, Donohoe CL, Dunne MR, Davern M, Donlon NE
- 332 Liquid biopsy in cholangiocarcinoma: Current status and future perspectives Rompianesi G, Di Martino M, Gordon-Weeks A, Montalti R, Troisi R

MINIREVIEWS

- 351 Biomarkers for hepatocellular carcinoma based on body fluids and feces Guan MC, Ouyang W, Wang MD, Liang L, Li N, Fu TT, Shen F, Lau WY, Xu QR, Huang DS, Zhu H, Yang T
- 366 Molecular-targeted therapy toward precision medicine for gastrointestinal cancer: Current progress and challenges Matsuoka T, Yashiro M
- 391 What is the best surgical procedure of transverse colon cancer? An evidence map and minireview Li C, Wang Q, Jiang KW
- 400 Update on the management of the gastrointestinal effects of radiation McCaughan H, Boyle S, McGoran JJ
- 409 Plexiform fibromyxoma: Review of rare mesenchymal gastric neoplasm and its differential diagnosis Arslan ME, Li H, Fu Z, Jennings TA, Lee H

ORIGINAL ARTICLE

Retrospective Study

424 Outcomes of curative liver resection for hepatocellular carcinoma in patients with cirrhosis Elshaarawy O, Aman A, Zakaria HM, Zakareya T, Gomaa A, Elshimi E, Abdelsameea E

Observational Study

440 Same day yttrium-90 radioembolization with single photon emission computed tomography/computed tomography: An opportunity to improve care during the COVID-19 pandemic and beyond

Elsayed M, Loya M, Galt J, Schuster DM, Bercu ZL, Newsome J, Brandon D, Benenati S, Behbahani K, Duszak R, Sethi I, Kokahi N

SYSTEMATIC REVIEWS

453 Sex as an effect modifier in the association between alcohol intake and gastric cancer risk Bae JM



Contents

World Journal of Gastrointestinal Oncology

Monthly Volume 13 Number 5 May 15, 2021

ABOUT COVER

Editorial Board Member of World Journal of Gastrointestinal Oncology, Simona Maria Bataga, PhD, Professor, Department of Gastroenterology, University of Medicine, Pharmacy, Science and Technology, GE Palade, Targu-Mures 540085, Romania. simonabataga@yahoo.com

AIMS AND SCOPE

The primary aim of World Journal of Gastrointestinal Oncology (WJGO, World J Gastrointest Oncol) is to provide scholars and readers from various fields of gastrointestinal oncology with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

WJGO mainly publishes articles reporting research results and findings obtained in the field of gastrointestinal oncology and covering a wide range of topics including liver cell adenoma, gastric neoplasms, appendiceal neoplasms, biliary tract neoplasms, hepatocellular carcinoma, pancreatic carcinoma, cecal neoplasms, colonic neoplasms, colorectal neoplasms, duodenal neoplasms, esophageal neoplasms, gallbladder neoplasms, etc.

INDEXING/ABSTRACTING

The WJGO is now indexed in Science Citation Index Expanded (also known as SciSearch®), PubMed, PubMed Central, and Scopus. The 2020 edition of Journal Citation Reports® cites the 2019 impact factor (IF) for WJGO as 2.898; IF without journal self cites: 2.880; 5-year IF: 3.316; Ranking: 143 among 244 journals in oncology; Quartile category: Q3; Ranking: 55 among 88 journals in gastroenterology and hepatology; and Quartile category: Q3. The WJGO's CiteScore for 2019 is 2.0 and Scopus CiteScore rank 2019: Gastroenterology is 86/137.

RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: Jia-Hui Li; Production Department Director: Xiang Li; Editorial Office Director: Ya-Juan Ma.

NAME OF JOURNAL	INSTRUCTIONS TO AUTHORS
World Journal of Gastrointestinal Oncology	https://www.wignet.com/bpg/gerinfo/204
ISSN	GUIDELINES FOR ETHICS DOCUMENTS
ISSN 1948-5204 (online)	https://www.wjgnet.com/bpg/GerInfo/287
LAUNCH DATE	GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH
February 15, 2009	https://www.wignet.com/bpg/gerinfo/240
FREQUENCY	PUBLICATION ETHICS
Monthly	https://www.wjgnet.com/bpg/GerInfo/288
EDITORS-IN-CHIEF	PUBLICATION MISCONDUCT
Monjur Ahmed, Florin Burada, Pashtoon Kasi, Rosa M Jimenez Rodriguez	https://www.wjgnet.com/bpg/gerinfo/208
EDITORIAL BOARD MEMBERS	ARTICLE PROCESSING CHARGE
https://www.wjgnet.com/1948-5204/editorialboard.htm	https://www.wjgnet.com/bpg/gerinfo/242
PUBLICATION DATE	STEPS FOR SUBMITTING MANUSCRIPTS
May 15, 2021	https://www.wjgnet.com/bpg/GerInfo/239
COPYRIGHT	ONLINE SUBMISSION
© 2021 Baishideng Publishing Group Inc	https://www.f6publishing.com

© 2021 Baishideng Publishing Group Inc. All rights reserved. 7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA E-mail: bpgoffice@wjgnet.com https://www.wjgnet.com



0 $W \mathcal{J}$

World Journal of Gastrointestinal Oncology

Submit a Manuscript: https://www.f6publishing.com

World J Gastrointest Oncol 2021 May 15; 13(5): 453-461

DOI: 10.4251/wjgo.v13.i5.453

ISSN 1948-5204 (online)

SYSTEMATIC REVIEWS

Sex as an effect modifier in the association between alcohol intake and gastric cancer risk

Jong-Myon Bae

ORCID number: Jong-Myon Bae 0000-0003-3080-7852.

Author contributions: Bae JM performed to select related articles, conduct statistical analysis, and write the paper.

Conflict-of-interest statement: The author declares no conflict of interests and no funding sources for this article.

PRISMA 2009 Checklist statement:

The authors have read the PRISMA 2009 Checklist, and the manuscript was prepared and revised according to the PRISMA 2009 Checklist.

Open-Access: This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: htt p://creativecommons.org/License s/by-nc/4.0/

Manuscript source: Invited manuscript

Jong-Myon Bae, Department of Preventive Medicine, Jeju National University College of Medicine, Jeju-si 63243, Jeju, South Korea

Corresponding author: Jong-Myon Bae, MD, PhD, Full Professor, Department of Preventive Medicine, Jeju National University College of Medicine, 102 Jejudaehka-ro, Jeju-si 63243, Jeju, South Korea. jmbae@jejunu.ac.kr

Abstract

BACKGROUND

The results of previous meta-analyses evaluating the association between the alcohol intake and gastric cancer risk have reported that a statistical significance only for men.

AIM

To investigate the different association between alcohol intake and gastric cancer risk between men and women.

METHODS

The selection criteria included a prospective cohort study for evaluating alcohol intake and gastric cancer risk, with relative risks adjusted for potential confounders. Adjusted relative risk (RR) for the potential confounders and its 95% confidence interval (CI) in the highest vs lowest level were extracted from each study and a random-effects meta-analysis was conducted. Subgroup analyses by region, level of adjustment for smoking status, adjusting for body mass index, and year of publication were conducted.

RESULTS

A meta-analysis of all 27 cohorts showed that alcohol intake increased the risk of gastric cancer (summary RR = 1.13, 95% CI: 1.04-1.23, *I*² = 58.2%). Further, 13 men's cohorts had higher summary RR while maintaining statistical significance, and only seven women's cohorts had no statistical significance.

CONCLUSION

The present review suggests that alcohol consumption increases the risk of gastric cancer in men. These findings showed that the sex variable in the association between alcohol intake and gastric cancer risk seemed to be an effect modifier with an interaction term. It is necessary to re-estimate follow-up outcomes after stratifying for sex.



WJGO | https://www.wjgnet.com

Specialty type: Oncology

Country/Territory of origin: South Korea

Peer-review report's scientific quality classification

Grade A (Excellent): 0 Grade B (Very good): 0 Grade C (Good): C, C Grade D (Fair): 0 Grade E (Poor): 0

Received: November 27, 2020 Peer-review started: November 27, 2020 First decision: February 14, 2021 Revised: February 22, 2021 Accepted: April 13, 2021 Article in press: April 13, 2021

Published online: May 15, 2021

P-Reviewer: Yu PF S-Editor: Fan JR L-Editor: A P-Editor: Li JH



Key Words: Alcohol; Stomach neoplasm; Effect modifier; Cohort studies; Meta-analysis; **Risk** factors

©The Author(s) 2021. Published by Baishideng Publishing Group Inc. All rights reserved.

Core Tip: The present review suggests that alcohol consumption increases the risk of gastric cancer, especially in men. These findings showed that the sex variable in the association between alcohol intake and gastric cancer risk seemed to be an effect modifier with an interaction term. It is necessary to re-estimate follow-up outcomes after stratifying for sex.

Citation: Bae JM. Sex as an effect modifier in the association between alcohol intake and gastric cancer risk. World J Gastrointest Oncol 2021; 13(5): 453-461

URL: https://www.wjgnet.com/1948-5204/full/v13/i5/453.htm DOI: https://dx.doi.org/10.4251/wjgo.v13.i5.453

INTRODUCTION

Global cancer statistics 2018 reported that gastric cancer was the fifth most frequently diagnosed cancer and the third leading cause of cancer-related death[1]. As gastric cancer is known to be a multifactorial disease^[2], modifiable risk factors such as *Helico*bacter pylori and Epstein-Barr virus infection, diet, smoking status, and alcohol intake have been identified[3-6].

Table 1 summarizes the results of three meta-analyses published in 2017, that evaluated the association between alcohol intake and gastric cancer risk[7-9]. All summary relative risk (sRR) was over 1, but the results of statistical significance conflicted with each other. Interestingly, all meta-analyses reported that the 95% confidence interval (CI) of sRR in men did not involve 1. This indicates a statistically significant association between alcohol intake and gastric cancer risk in men. However, women did not have statistical significance in any of the meta-analyses. In addition, He et al[8] reported that light alcohol intake was associated with a reduction in gastric cancer in women (sRR = 0.74, 95%CI: 0.57-0.98).

Based on these findings, the author hypothesized that alcohol intake's association with gastric cancer risk may differ between men and women. Thus, the aim was to investigate the suggested hypothesis targeting three meta-analyses in Table 1 and Tramacere *et al*^[10]'s study by performing a meta-epidemiological review^[11].

MATERIALS AND METHODS

Selection strategies

The selection criterion for this meta-epidemiological study was as follows: A prospective cohort study for evaluating alcohol intake and gastric cancer risk showing RR adjusted for potential confounders.

Of the cohort studies selected for conducting meta-analysis by four existing systematic reviews [7-10], a total of 18 studies met the selection criteria [12-29]. Since the latest year of publication, of the 18 studies, was 2015[29], cohort studies published until July 31, 2020 were needed. The articles that cited the 18 selected studies was listed using the "cited by" option on PubMed[30]. From this, additional cohort studies meeting the selection criteria were secured. After checking for duplication of cohort participants among the selected cohort studies, a study with more gastric cancer patients was selected between duplicate studies.

Statistical analysis

Adjusted RR for potential confounders and its 95% CI in the highest vs lowest level were extracted by sex from each study. As the reference group of Buckland *et al*[27] was the moderate/high-intake group, the adjusted RR of the study was taken by the reciprocal of the adjusted RR of the no/low-intake group. The level of adjustment for



Table 1 Summary of previous systematic reviews for evaluating the association between alcohol intake and gastric cancer risk					
Ref.	Searching	Selected studies (Cohort)	Group	Summary relative risk (95% confidence interval)	₽ (%)
Han <i>et al</i> [7], 2017	Dec-16	23	Both, HLL	1.17 (1.00-1.34)	79.6
		7	Men, HLL	1.18 (1.06-1.30)	0
		1	Women, HLL	1.13 (0.79-2.25)	0
Wang <i>et al</i> [9], 2017	Dec-16	17	Both, HLL	1.19 (1.06-1.34)	37.6
		34	Men, HLL	1.21 (1.06-1.37)	68.2
		12	Women, HLL	1.18 (0.95-1.47)	26.2
He et al[8], 2017	Apr-17	22	Both, HLL	1.03 (0.99-1.08)	21.9
			Men, heavy	1.13 (1.06-1.22)	28.1
			Women, heavy	1.33 (0.79-2.24)	2.4

HLL: Highest versus lowest level.

smoking status and the adjustment for body mass index in each cohort study were evaluated. A high level of smoking status was defined as \geq 3 in the definition suggested by Thomas and Hodges[31]. They defined three levels as adjustments with less than four categories based on smoking status and intensity.

The level of heterogeneity among cohorts was evaluated using the I-squared value, and a random-effects model meta-analysis was performed[32]. In addition, subgroup analyses by region, level of adjustment for smoking status, adjusting for body mass index, and year of publication were conducted to evaluate the effects of potential confounders. The level of statistical significance was set at P < 0.05.

RESULTS

Final selection

The list made using the "cited by" option on PubMed on July 31, 2020 contained a total of 411 articles. Five cohort studies meeting the selection criteria were obtained from the list[33-37]. While checking for duplication of cohort participants, the author found that three studies of the Honolulu Heart Program[12,15], two of the European Prospective Investigation into Cancer and Nutrition cohort[13,27], and two of the NIH-AARP diet and health cohort[14,36] had the same cohort participants, respectively. Thus Nomura *et al*[12], Duell *et al*[13], and Freedman *et al*[14] were excluded based on the number of gastric cancer patients. Finally, 20 cohort studies with a total of 26864280 participants were selected (Figure 1)[15-29,33-37]. There were 10 Asian, 7 European, and 3 American studies in the regional distribution. They consisted of 27 cohorts by sex: 13 men's, 7 women's, and 7 adjusted for sex.

Summary effect size

A meta-analysis of all 27 cohorts showed that alcohol intake increased the risk of gastric cancer (sRR = 1.13, 95%CI: 1.04-1.23, l^2 = 58.2%) (Figure 2). When subgroup analysis by sex was performed, the 13 men's cohorts had higher sRR while maintaining statistical significance (sRR = 1.18, 95%CI: 1.06-1.32, l^2 = 55.5%), but the seven women's cohorts (sRR = 1.07, 95%CI: 0.96-1.19, l^2 = 0.0%) and seven cohorts adjusted for sex (sRR = 1.05, 95%CI: 0.83-1.33, l^2 = 61.6%) had no statistical significance.

The subgroup analysis of the 13 men's cohorts showed that there was statistical significance in Asians, in the group with a high level of adjustment for smoking status, in the group with the adjustment for body mass index, and in more recently published studies (Table 2). These results were not found in the seven women's cohorts.

Raisbideng® WJGO | https://www.wjgnet.com

Table 2 Subgroup analysis by potential confounders ¹					
	Men	Women	Both		
All	1.18 (1.06-1.32) [13]	1.07 (0.95-1.19) [7]	1.13 (1.04-1.23) [27]		
Region					
Asia	1.22 (1.09-1.36) [8]	1.09 (0.91-1.29) [3]	1.43 (1.02-1.28) [13]		
Non-Asia	1.12 (0.83-1.50) [5]	1.07 (0.83-1.38) [4]	1.11 (0.99-1.24) [14]		
level of adjustment of smoking status					
Low	1.14 (0.91-1.41) [7]	1.07 (0.95-1.20) [5]	1.16 (1.06-1.27) [10]		
High	1.19 (1.08-1.31) [6]	1.09 (0.84-1.43) [2]	1.12 (0.98-1.27) [17]		
Adjustment of body mass index					
No	1.05 (0.83-1.34) [5]	1.48 (0.93-2.36) [2]	1.12 (0.92-1.36) [8]		
Yes	1.22 (1.08-1.37) [8]	1.05 (0.96-1.17) [5]	1.13 (1.03-1.24) [19]		
ear of publication					
Approximately 2005	1.08 (0.88-1.33) [4]	[0]	1.08 (0.89-1.33) [5]		
2006-2010	1.07 (0.81-1.41) [3]	1.48 (0.93-2.36) [2]	1.14 (0.98-1.32) [8]		
2011-	1.26 (1.02-1.56) [6]	1.05 (0.95-1.17) [5]	1.14 (1.00-1.29) [14]		
Bite					
Cardia	1.07 (0.79-1.44) [1]	1.30 (0.43-3.90) [1]	1.05 (0.81-1.35) [3]		
Non-cardia	0.75 (0.53-1.06) [1]	0.66 (0.24-1.82) [1]	0.84 (0.65-1.08) [3]		

¹Summary relative risk (95% confidence interval) [number of cohorts].

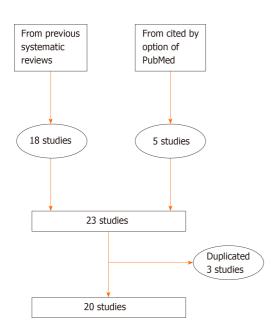


Figure 1 Flow chart of the final selection of prospective cohort studies.

DISCUSSION

Summary of the main finding

The results show that alcohol intake increased the risk of gastric cancer, especially in men. However, this association was not seen in women.

Differences between sex groups

Compared to the sRR of 1.21 in men's cohorts of Wang et al[9] in Table 1, the sRR of



Year	Author	Site	Adjusting smoking status	djusting body nass index	Relative risk (95%CI)	% Weight
MEN					1	
1990	Stemmermann	А	н	N	◆ 1.17 (0.73, 1.89)) 2.50
1998	Galamis	А	L	N	◆ 1.20 (0.53, 2.74)) 0.99
2002	Sasazuki	А	н	Y	• 1.10 (0.78, 1.56)) 3.98
2005	Nakaya	А	н	N	1.00 (0.71, 1.41)) 3.98
2007	Sung	А	н	Y	 1.20 (1.06, 1.35)) 9.31
2008	Song	А	L	N	0.56 (0.29, 1.09)) 1.46
2010	Moy	А	н	Y	◆ 1.15 (0.85, 1.55)) 4.75
2012	Everatt	А	н	Y	1.90 (1.13, 3.19)) 2.21
2015	Jayalekshmi	А	L	N	1.30 (0.87, 1.94)) 3.28
2017	Choi	А	L	Y	• 1.26 (1.24, 1.29)) 11.34
2018	Wang	Ν	L	Y	0.75 (0.53, 1.06)) 3.98
2018	Wang	С	L	Υ	1.07 (0.79, 1.44)) 4.75
2019	Li	А	L	Y	1.85 (1.35, 2.53)) 4.50
Subtot	al (I-squared = 5	55.5%,	p = 0.008)		1.18 (1.06, 1.31)) 57.03
Wome	EN				I	
2007	Larsson	А	н	N	1.33 (0.79, 2.24)) 2.17
2008	Song	А	L	N	2.23 (0.79, 6.29)) 0.64
2009	Allen	А	н	Y — •	1.02 (0.74, 1.40)) 4.48
2017	Choi	А	L	Y 🚽	► 1.06 (0.94, 1.19)) 9.41
2018	Wang	Ν	L	Y	0.66 (0.24, 1.82)) 0.67
2018	Wang	С	L	Y	1.30 (0.43, 3.90)) 0.58
2019	Li	А	L	Y	1.34 (0.33, 5.45)) 0.36
Subtot	al (I-squared = 0	0.0%, p	o = 0.705)	<	1.07 (0.96, 1.19)) 18.32
Adjust	ed					
2005	Barstad	А	L	N	◆ 1.13 (0.53, 2.41)) 1.15
2006	Sjodahl	А	L	Y —	1.49 (0.78, 2.84)) 1.53
2009	Steevens	Ν	н	Y	1.00 (0.68, 1.47)) 3.45
2009	Steevens	С	н	Y	0.90 (0.50, 1.63)) 1.76
2014	Buckland	А	L	Y	1.20 (1.00, 1.45)) 7.43
2015	Ma	А	L	Y 🗕	1.36 (0.95, 1.95)) 3.75
2017	Wang	А	L	Y	0.69 (0.53, 0.89)) 5.58
Subtot	al (I-squared = 6	61.6%,	p = 0.016)	\sim	1.05 (0.83, 1.33)) 24.66
Overal	I (I-squared = 58	3.2%, j	o = 0.000)		1.13 (1.04, 1.23)) 100.00
NOTE	Weights are fro	m rano	lom effects a	llysis	1	
				0.25 1	2	

Figure 2 Forest plot of estimating the summary relative risk. A: All; C: Cardia; N: Non-cardia; H: High level; L: Low level; Y: Yes; N: No; CI: Confidence interval.

> 1.13 estimated from 13 cohorts was the almost the same level, but the CI was narrower. The sRR of men's cohorts published more recently was the highest and was statistically significant. Cumulative meta-analysis showed that the sRR converged as it moved from the past to the present (Figure 3).

> However, the results of the women's cohorts showed that alcohol intake might not increase the risk of gastric cancer. This finding can be supported by the results of He et *al*[8], who reported that light alcohol intake was associated with a reduction in gastric cancer in women (sRR = 0.74, 95%CI: 0.57-0.98). In addition, incidence rates are twofold higher in men than in women[1]. Thus, the sex variable in the association between alcohol intake and gastric cancer risk seems not to be a simple confounder but be an effect modifier having an interaction term[38]. In other words, seven cohorts adjusted for sex need to re-estimate outcomes stratified by sex.

Inferences about subgroup analyses

The subgroup analysis of 13 men's cohorts indicated that there was statistical significance in Asians, in the group with the high level of adjustment for smoking status, and in the group adjusted for body mass index. Interestingly, the statistical significance was not shown in the group with a low level of adjustment for smoking status, and in the group not adjusted for body mass index. This is because a RR generally shifts to null as the potential confounder is strengthened. These phenomena strongly support the hypothesis that alcohol intake increases the risk of gastric cancer in men.

Limitations

The main limitation is that the category of alcohol intake varies in each study, such as times per week, amount consumed per day, none/moderate/heavy, or never/



WJGO | https://www.wjgnet.com

Year	Author	Site		Cumulative relative risk (95%CI)
1990	Stemmermann	A		1.17 (0.73, 1.89)
1998	Galamis	А		- 1.18 (0.78, 1.78)
2002	Sasazuki	А		1.13 (0.87, 1.48)
2005	Nakaya	А		1.08 (0.88, 1.33)
2007	Sung	А		1.17 (1.05, 1.30)
2008	Song	А		1.12 (0.98, 1.28)
2010	Моу	A		1.15 (1.04, 1.27)
2012	Everatt	А		1.15 (1.00, 1.32)
2015	Jayalekshmi	А		1.16 (1.03, 1.32)
2017	Choi	А	_ _	1.21 (1.12, 1.31)
2018	Wang	Ν		1.15 (1.03, 1.28)
2018	Wang	С		1.15 (1.03, 1.27)
2019	Li	А		1.18 (1.06, 1.31)
		0.5	1 1.5	

Figure 3 Cumulative meta-analysis for the risk of gastric cancer in men by alcohol intake. A: All; C: Cardia; N: Non-cardia; CI: Confidence interval.

former/current drinker. Therefore, the author extracted the results of the highest and lowest levels from each study and applied a random effect model. Another limitation is that the author could not perform subgroup analysis for cardia and non-cardia because only three cohorts were selected. Thus, the author could not evaluate the argument by sex that "intestinal non-cardia carcinoma was accompanied by heavy alcohol consumption"[3].

CONCLUSION

In conclusion, the present study suggests that alcohol consumption increases the risk of gastric cancer in men. It is necessary to re-estimate the follow-up outcomes by stratification for sex to determine whether there is a sex difference in the association between alcohol intake and gastric cancer risk.

ARTICLE HIGHLIGHTS

Research background

The previous systematic reviews showed a statistically significant association between alcohol intake and gastric cancer risk in men. However, women did not have statistical significance in any of the meta-analyses.

Research motivation

The author hypothesized that alcohol intake's association with gastric cancer risk may differ between men and women.

Research objectives

The aim was to investigate the suggested hypothesis targeting four previous metaanalyses by performing a meta-epidemiological review.

Research methods

After securing additional cohort studies meeting the selection criteria, updated metaanalysis and subgroup analysis by sex were conducted.

Reisbideng® WJGO https://www.wjgnet.com

Research results

The subgroup analysis of the 13 men's cohorts showed that there was statistical significance in Asians, in the group with a high level of adjustment for smoking status, in the group with the adjustment for body mass index, and in more recently published studies. These results were not found in the seven women's cohorts.

Research conclusions

The present study suggests that alcohol consumption increases the risk of gastric cancer in men.

Research perspectives

It is necessary to re-estimate the follow-up outcomes by stratification for sex to determine whether there is a sex difference in the association between alcohol intake and gastric cancer risk.

REFERENCES

- Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: 1 GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018; 68: 394-424 [PMID: 30207593 DOI: 10.3322/caac.21492]
- Yusefi AR, Bagheri Lankarani K, Bastani P, Radinmanesh M, Kavosi Z. Risk Factors for Gastric Cancer: A Systematic Review Asian Pac J Cancer Prev 2018; 19: 591-603 [PMID: 29579788 DOI: 10.22034/APJCP.2018.19.3.591]
- 3 Machlowska J, Baj J, Sitarz M, Maciejewski R, Sitarz R. Gastric Cancer: Epidemiology, Risk Factors, Classification, Genomic Characteristics and Treatment Strategies. Int J Mol Sci 2020; 21 [PMID: 32512697 DOI: 10.3390/ijms21114012]
- 4 Wang C, Yuan Y, Hunt RH. The association between Helicobacter pylori infection and early gastric cancer: a meta-analysis. Am J Gastroenterol 2007; 102: 1789-1798 [PMID: 17521398 DOI: 10.1111/j.1572-0241.2007.01335.x]
- 5 Bae JM, Kim EH. Epstein-Barr Virus and Gastric Cancer Risk: A Meta-analysis With Metaregression of Case-control Studies. J Prev Med Public Health 2016; 49: 97-107 [PMID: 27055546 DOI: 10.3961/jpmph.15.068]
- Bae JM, Kim EH. Dietary intakes of citrus fruit and risk of gastric cancer incidence: an adaptive 6 meta-analysis of cohort studies. Epidemiol Health 2016; 38: e2016034 [PMID: 27457064 DOI: 10.4178/epih.e2016034]
- 7 Han X, Xiao L, Yu Y, Chen Y, Shu HH. Alcohol consumption and gastric cancer risk: a metaanalysis of prospective cohort studies. Oncotarget 2017; 8: 83237-83245 [PMID: 29137337 DOI: 10.18632/oncotarget.19177
- 8 He Z, Zhao TT, Xu HM, Wang ZN, Xu YY, Song YX, Ni ZR, Xu H, Yin SC, Liu XY, Miao ZF. Association between alcohol consumption and the risk of gastric cancer: a meta-analysis of prospective cohort studies. Oncotarget 2017; 8: 84459-84472 [PMID: 29137439 DOI: 10.18632/oncotarget.20880]
- Wang PL, Xiao FT, Gong BC, Liu FN. Alcohol drinking and gastric cancer risk: a meta-analysis of 9 observational studies. Oncotarget 2017; 8: 99013-99023 [PMID: 29228746 DOI: 10.18632/oncotarget.20918]
- 10 Tramacere I, Negri E, Pelucchi C, Bagnardi V, Rota M, Scotti L, Islami F, Corrao G, La Vecchia C, Boffetta P. A meta-analysis on alcohol drinking and gastric cancer risk. Ann Oncol 2012; 23: 28-36 [PMID: 21536659 DOI: 10.1093/annonc/mdr135]
- 11 Murad MH, Wang Z. Guidelines for reporting meta-epidemiological methodology research. Evid Based Med 2017; 22: 139-142 [PMID: 28701372 DOI: 10.1136/ebmed-2017-110713]
- Nomura A, Grove JS, Stemmermann GN, Severson RK. A prospective study of stomach cancer and 12 its relation to diet, cigarettes, and alcohol consumption. Cancer Res 1990; 50: 627-631 [PMID: 2297702
- Duell EJ, Travier N, Lujan-Barroso L, Clavel-Chapelon F, Boutron-Ruault MC, Morois S, Palli D, 13 Krogh V, Panico S, Tumino R, Sacerdote C, Quirós JR, Sánchez-Cantalejo E, Navarro C, Gurrea AB, Dorronsoro M, Khaw KT, Allen NE, Key TJ, Bueno-de-Mesquita HB, Ros MM, Numans ME, Peeters PH, Trichopoulou A, Naska A, Dilis V, Teucher B, Kaaks R, Boeing H, Schütze M, Regner S, Lindkvist B, Johansson I, Hallmans G, Overvad K, Egeberg R, Tjønneland A, Lund E, Weiderpass E, Braaten T, Romieu I, Ferrari P, Jenab M, Stenling R, Aune D, Norat T, Riboli E, González CA. Alcohol consumption and gastric cancer risk in the European Prospective Investigation into Cancer and Nutrition (EPIC) cohort. Am J Clin Nutr 2011; 94: 1266-1275 [PMID: 21993435 DOI: 10.3945/aicn.111.012351]
- 14 Freedman ND, Abnet CC, Leitzmann MF, Mouw T, Subar AF, Hollenbeck AR, Schatzkin A. A prospective study of tobacco, alcohol, and the risk of esophageal and gastric cancer subtypes. Am J Epidemiol 2007; 165: 1424-1433 [PMID: 17420181 DOI: 10.1093/aje/kwm051]
- 15 Stemmermann GN, Nomura AM, Chyou PH, Yoshizawa C. Prospective study of alcohol intake and



large bowel cancer. Dig Dis Sci 1990; 35: 1414-1420 [PMID: 2226103 DOI: 10.1007/BF01536750]

- Galanis DJ, Kolonel LN, Lee J, Nomura A. Intakes of selected foods and beverages and the 16 incidence of gastric cancer among the Japanese residents of Hawaii: a prospective study. Int J Epidemiol 1998; 27: 173-180 [PMID: 9602395 DOI: 10.1093/ije/27.2.173]
- 17 Sasazuki S, Sasaki S, Tsugane S; Japan Public Health Center Study Group. Cigarette smoking, alcohol consumption and subsequent gastric cancer risk by subsite and histologic type. Int J Cancer 2002; 101: 560-566 [PMID: 12237898 DOI: 10.1002/ijc.10649]
- 18 Barstad B, Sørensen TI, Tjønneland A, Johansen D, Becker U, Andersen IB, Grønbaek M. Intake of wine, beer and spirits and risk of gastric cancer. Eur J Cancer Prev 2005; 14: 239-243 [PMID: 15901992 DOI: 10.1097/00008469-200506000-00007]
- Nakaya N, Tsubono Y, Kuriyama S, Hozawa A, Shimazu T, Kurashima K, Fukudo S, Shibuya D, 19 Tsuji I. Alcohol consumption and the risk of cancer in Japanese men: the Miyagi cohort study. Eur J Cancer Prev 2005; 14: 169-174 [PMID: 15785321 DOI: 10.1097/00008469-200504000-00013]
- 20 Sjödahl K, Lu Y, Nilsen TI, Ye W, Hveem K, Vatten L, Lagergren J. Smoking and alcohol drinking in relation to risk of gastric cancer: a population-based, prospective cohort study. Int J Cancer 2007; 120: 128-132 [PMID: 17036324 DOI: 10.1002/ijc.22157]
- Larsson SC, Giovannucci E, Wolk A. Alcoholic beverage consumption and gastric cancer risk: a 21 prospective population-based study in women. Int J Cancer 2007; 120: 373-377 [PMID: 17066442 DOI: 10.1002/ijc.22204]
- 22 Sung NY, Choi KS, Park EC, Park K, Lee SY, Lee AK, Choi IJ, Jung KW, Won YJ, Shin HR. Smoking, alcohol and gastric cancer risk in Korean men: the National Health Insurance Corporation Study. Br J Cancer 2007; 97: 700-704 [PMID: 17637680 DOI: 10.1038/sj.bjc.6603893]
- 23 Song HJ, Kim HJ, Choi NK, Hahn S, Cho YJ, Park BJ, Gender differences in gastric cancer incidence in elderly former drinkers. Alcohol 2008; 42: 363-368 [PMID: 18579337 DOI: 10.1016/j.alcohol.2008.04.005]
- Steevens J, Schouten LJ, Goldbohm RA, van den Brandt PA. Alcohol consumption, cigarette 24 smoking and risk of subtypes of oesophageal and gastric cancer: a prospective cohort study. Gut 2010; 59: 39-48 [PMID: 19828467 DOI: 10.1136/gut.2009.191080]
- Moy KA, Fan Y, Wang R, Gao YT, Yu MC, Yuan JM. Alcohol and tobacco use in relation to gastric 25 cancer: a prospective study of men in Shanghai, China. Cancer Epidemiol Biomarkers Prev 2010; 19: 2287-2297 [PMID: 20699372 DOI: 10.1158/1055-9965.EPI-10-0362]
- 26 Everatt R, Tamosiunas A, Kuzmickiene I, Virviciute D, Radisauskas R, Reklaitiene R, Milinaviciene E. Alcohol consumption and risk of gastric cancer: a cohort study of men in Kaunas, Lithuania, with up to 30 years follow-up. BMC Cancer 2012; 12: 475 [PMID: 23066954 DOI: 10.1186/1471-2407-12-475]
- Buckland G, Travier N, Huerta JM, Bueno-de-Mesquita HB, Siersema PD, Skeie G, Weiderpass E, 27 Engeset D, Ericson U, Ohlsson B, Agudo A, Romieu I, Ferrari P, Freisling H, Colorado-Yohar S, Li K, Kaaks R, Pala V, Cross AJ, Riboli E, Trichopoulou A, Lagiou P, Bamia C, Boutron-Ruault MC, Fagherazzi G, Dartois L, May AM, Peeters PH, Panico S, Johansson M, Wallner B, Palli D, Key TJ, Khaw KT, Ardanaz E, Overvad K, Tjønneland A, Dorronsoro M, Sánchez MJ, Quirós JR, Naccarati A, Tumino R, Boeing H, Gonzalez CA. Healthy lifestyle index and risk of gastric adenocarcinoma in the EPIC cohort study. Int J Cancer 2015; 137: 598-606 [PMID: 25557932 DOI: 10.1002/ijc.29411]
- Jayalekshmi PA, Hassani S, Nandakumar A, Koriyama C, Sebastian P, Akiba S. Gastric cancer risk 28 in relation to tobacco use and alcohol drinking in Kerala, India--Karunagappally cohort study. World J Gastroenterol 2015; 21: 12676-12685 [PMID: 26640345 DOI: 10.3748/wjg.v21.i44.12676]
- 29 Ma SH, Jung W, Weiderpass E, Jang J, Hwang Y, Ahn C, Ko KP, Chang SH, Shin HR, Yoo KY, Park SK. Impact of alcohol drinking on gastric cancer development according to Helicobacter pylori infection status. Br J Cancer 2015; 113: 1381-1388 [PMID: 26379079 DOI: 10.1038/bjc.2015.333]
- Bae JM, Kim EH. Citation Discovery Tools for Conducting Adaptive Meta-analyses to Update 30 Systematic Reviews. J Prev Med Public Health 2016; 49: 129-133 [PMID: 27055549 DOI: 10.3961/jpmph.15.074]
- Thomas DR, Hodges ID. Dietary Research on Coffee: Improving Adjustment for Confounding. Curr 31 Dev Nutr 2020; 4: nzz142 [PMID: 31938763 DOI: 10.1093/cdn/nzz142]
- 32 Harris RJ, Bradburn MJ, Deeks JJ, Harbord RM, Altman DG, Sterne JAC. metan: Fixed- and random-effects meta-analysis. Stata J 2008; 8: 3-28 [DOI: 10.1007/s00355-007-0273-9]
- Allen NE, Beral V, Casabonne D, Kan SW, Reeves GK, Brown A, Green J; Million Women Study 33 Collaborators. Moderate alcohol intake and cancer incidence in women. J Natl Cancer Inst 2009; 101: 296-305 [PMID: 19244173 DOI: 10.1093/jnci/djn514]
- Choi YJ, Lee DH, Han KD, Kim HS, Yoon H, Shin CM, Park YS, Kim N. The relationship between 34 drinking alcohol and esophageal, gastric or colorectal cancer: A nationwide population-based cohort study of South Korea. PLoS One 2017; 12: e0185778 [PMID: 28973012 DOI: 10.1371/journal.pone.0185778]
- Wang Z, Koh WP, Jin A, Wang R, Yuan JM. Composite protective lifestyle factors and risk of 35 developing gastric adenocarcinoma: the Singapore Chinese Health Study. Br J Cancer 2017; 116: 679-687 [PMID: 28125822 DOI: 10.1038/bjc.2017.7]
- 36 Wang S, Freedman ND, Loftfield E, Hua X, Abnet CC. Alcohol consumption and risk of gastric cardia adenocarcinoma and gastric noncardia adenocarcinoma: A 16-year prospective analysis from the NIH-AARP diet and health cohort. Int J Cancer 2018; 143: 2749-2757 [PMID: 29992560 DOI: 10.1002/ijc.31740]



- 37 Li Y, Eshak ES, Shirai K, Liu K, Dong JY, Iso H, Tamakoshi A; JACC Study Group. Alcohol Consumption and Risk of Gastric Cancer: The Japan Collaborative Cohort Study. J Epidemiol 2021; 31: 30-36 [PMID: 31902851 DOI: 10.2188/jea.JE20190304]
- 38 Deandrea S, Foschi R, Galeone C, La Vecchia C, Negri E, Hu J. Is temperature an effect modifier of the association between green tea intake and gastric cancer risk? Eur J Cancer Prev 2010; 19: 18-22 [PMID: 19864955 DOI: 10.1097/CEJ.0b013e328330eb1a]





Published by Baishideng Publishing Group Inc 7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA Telephone: +1-925-3991568 E-mail: bpgoffice@wjgnet.com Help Desk: https://www.f6publishing.com/helpdesk https://www.wjgnet.com

