OPEN ACCESS

University of Dundee

University of Dundee

Alcohol and cancer risk

Singhavi, Hitesh Rajendra; Singh, Arjun; Bhattacharjee, Atanu; Talole, Sanjay; Dikshit, Rajesh; Chaturvedi, Pankaj

DOI:
10.4103/ijph.IJPH_529_19

Publication date:
2020

Licence:
CC BY-NC-SA

Document Version
Publisher's PDF, also known as Version of record

Link to publication in Discovery Research Portal

Citation for published version (APA):
Singhavi, H. R., Singh, A., Bhattacharjee, A., Talole, S., Dikshit, R., & Chaturvedi, P. (2020). Alcohol and cancer risk: A systematic review and meta-analysis of prospective Indian studies. *Indian journal of public health*, *64*(2), 186 - 190. https://doi.org/10.4103/ijph.IJPH_529_19

General rights
Copyright and moral rights for the publications made accessible in Discovery Research Portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Download date: 24. Jan. 2025

Original Article

Alcohol and Cancer Risk: A Systematic Review and Meta-Analysis of Prospective Indian Studies

Hitesh Rajendra Singhavi[1], Arjun Singh[1], Atanu Bhattacharjee[2], Sanjay Talole[3], Rajesh Dikshit[4], Pankaj Chaturvedi[5]

[1]Fellow, [5]Professor, Department of Head and Neck Surgery, [2]Assitant Professor, [3]Scientific Officer-E, Section of Biostatistics, [4]Director, Centre for Cancer Epidemiology, Tata Memorial Centre and Homi Bhabha National Institute, Mumbai, Maharashtra, India

Downloaded from http://journals.lww.com/ijph by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC4/OAVpDDa8KKGKV0Ymy+78= on 07/04/2024

Abstract

Background: Alcohol increases risk of cancer of oral cavity and pharynx, esophagus, colorectal, liver, larynx, and female breast. **Objectives:** The objective of this study was to determine the relationship of alcohol and cancer in India by meta-analysis. **Methods:** Systematic Medline searches were performed to identify all the published literature associating alcohol and cancer in India. Initially, we retrieved 1509 studies, but after applying inclusion and exclusion criteria, only 29 studies were found eligible for our meta-analysis. **Results:** Our meta-analysis shows that alcohol consumption increases the risk of cancer with the odds ratio (OR) of 2.32 (95% confidence interval [CI]: 1.50–3.47) in case–control studies and relative risk of 1.52 (95% CI: 0.97–2.51) in cohort studies. It also shows that risk of oral cavity cancer increases by two times (OR: 1.92, 95% CI: 1.54–3.96) in the population consuming alcohol. Publication analysis showed that studies included in the meta-analysis had wide variation, suggesting good representation all over the country. **Conclusion:** The result from our meta-analysis supports our hypothesis that alcohol consumption increases the risk of cancer, implying immediate cessation of the habit for cancer risk reduction.

Key words: Alcohol, cancer risk, India, meta-analysis

Introduction

Alcohol is one of the leading risk factors for population health worldwide and has a direct impact on maternal and child health, infectious diseases (HIV, viral hepatitis, and tuberculosis), mental health, injuries, poisonings, and importantly noncommunicable disease including cancer.[1] Cancer is a leading cause of death in both low-income and high-income countries,[2] and the burden of cancer is expected to increase, especially in the developing countries.[3] The International Agency for Research on Cancer (IARC) has determined that alcohol consumption is causally related to oral cavity, oropharyngeal, hypopharyngeal, esophageal (squamous cell carcinoma), colon, rectal, laryngeal, and liver cancer. All these effects are multiplicative with concurrent tobacco use.[1] It has been established in the literature that effect of alcohol may vary with different geographical region. There is enough international literature which has comprehensively shown that alcohol increases risk of cancer of oral cavity and pharynx, esophagus, colorectal, liver, larynx, and female breast.[4] However, conclusive evidence on carcinogenic potential of alcohol in Indian population is lacking. Thus, we carried out this meta-analysis to explore the relationship between alcohol consumption and the development of cancer in an Indian scenario.

Materials and Methods

In this meta-analysis, we used the international PICOS format:

P – Population consists of patients with cancer diagnosed by pathology; I – Intervention/exposure consists of alcohol drinking; C – Comparative group consists of healthy individuals; O – To explore whether alcohol drinking will

Address for correspondence: Dr. Atanu Bhattacharjee, Section of Biostatistics, Center for Cancer Epidemiology, Tata Memorial Centre, Mumbai, Maharashtra, India.
E-mail: atanustat@gmail.com

Access this article online

Quick Response Code:

Website: www.ijph.in

DOI: 10.4103/ijph.IJPH_529_19

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

Submitted: 20-Oct-2019 **Revised:** 19-Feb-2020
Accepted: 27-Apr-2020 **Published:** 16-Jun-2020

How to cite this article: Singhavi HR, Singh A, Bhattacharjee A, Talole S, Dikshit R, Chaturvedi P. Alcohol and cancer risk: A systematic review and meta-analysis of prospective Indian studies. Indian J Public Health 2020;64:186-90.

Downloaded from http://journals.lww.com/ijph by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC4/OAVpDDa8KKGKV0Ymy+78= on 07/04/2024

increase the risk of cancer; and S-Study – case–control and cohort study.

Literature inclusion criteria

(1) Research methods to include case–control and cohort studies; (2) histopathologically proven cancer; (3) studies providing complete data; (4) studies which were published between 1980 and 2018; (5) studies which controlled for the main confounding factors, such as smoking tobacco, smokeless tobacco, Human papillomavirus (HPV), and diet; (6) studies done on Indian population; and (7) we considered only those studies published in English literature.

Literature exclusion criteria

(1) Studies did not meet the inclusion criteria; (2) studies had repetitive published data, duplicate data 3) Raw data was not sufficient, and the case groups and the control groups total sample size was <30 cases, (4) Same authors used the same case studies: Only the studies with the most samples and the latest published in the literature were used, and (5) animal experiments. (6) Studies based on non-Indian population.

Literature retrieval strategies

We searched Medline, PubMed, and Web of Science with MeSH terms "cancer," "alcohol drinking," and "India" following the Meta-analysis of Observational Studies in Epidemiology guidelines to identify relevant studies in the published literature. The searched was performed for articles published between 1980 and 2018 [Figure 1].

Extracting information, excel spreadsheet, and fetching information

(1) General information extracted was title, first author, and publication date. (2) The characteristics of the research were research type, number of cases and control group, and distribution (proportion) of men and women. (3) Data characteristics were measure of alcohol consumption, relative risk, and 95% confidence interval (CI) or odds ratio (OR) and 95% CI. If comparative data were not provided within the literature, it was obtained by statistical software. Study participants were divided into two groups: alcohol never user and ever alcohol user.

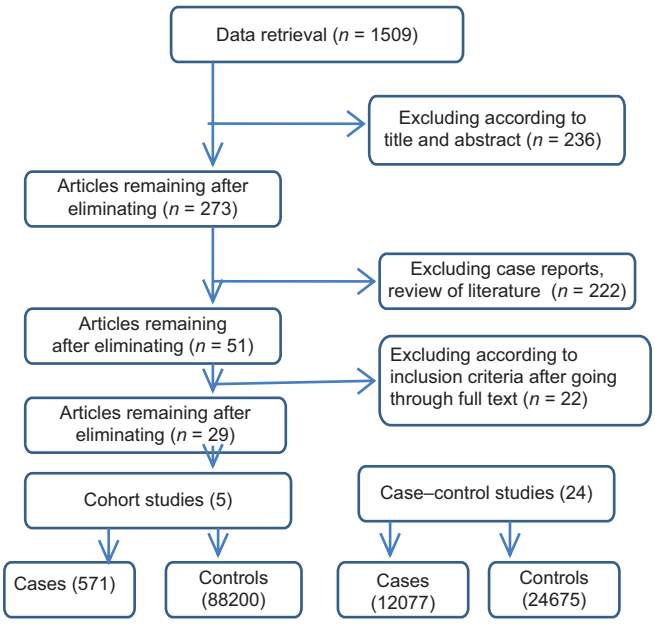

Figure 1: A flowchart depicting the study selection.

Statistical analysis

ORs obtained from each study were merged. The pooled estimate of OR was calculated. The sample size of each study was considered to provide weightage of a study. The forest plots were presented to show study-wise variation with OR. Data included (1) alcohol consumption and cancer risk, (2) nonalcohol consumption and cancer risk, (3) heterogeneity test and subgroup analysis, and (4) bias analysis.

Results

Adopting the search strategy, 1509 studies were retrieved; we excluded 1480 studies by following the aforementioned exclusion and inclusion criteria. The eligible 29 studies (24 case–control studies and 5 cohort studies) including a total of 286,986 persons were included in the 29 studies: case group ($n = 10,531$) and control group ($n = 276,455$) [Annexure Table 1]. Thus, the total number of cases included from case–control studies was 12,077 and of controls was included 24,875. On the other hand, the total numbers of cancer patients included from cohort studies were 571 while 88,200 were cancer free [Figure 2].

Meta-analysis of alcohol with cancer risk

We used an OR value to measure the effect quantity. To ensure the accuracy of the results and because of the high heterogeneity of the studies, we used the random effects model. The restricted maximum likelihood was adopted for Egger's test. The computation was performed with "metafor" package available in open-source software R(https://cran.r-project.org/). The pooled analysis for all studies was performed to show contribution of alcohol on cancer. The weightage of each study was distributed based on their sample size. The combined effect quantity for drinkers versus nondrinkers for case–control studies had an OR value of 2.15 with 95% CI of 1.50–3.47. This suggests that alcohol drinking can increase the risk for cancer. One of the hypotheses may be because alcohol acts as a solvent, assisting carcinogens to permeate the cells lining in the upper digestive tract more easily.

Alcohol with cancer risk in cohort studies

A total of 5 cohort studies were analyzed adding up to 571 cases and 88,200 controls, leading to pooled OR value of 1.52 (95% CI: 0.97–2.51) [Figure 2].

Alcohol with cancer risk in case–control studies

Since case–control studies and cohort studies have different implication, we decided to analyze them separately. A total 24 case–control studies were included in the analysis adding up to 36,952 individuals with 12,077 cases and 24,875 controls. We plotted a forest plot to determine the pooled OR value of 2.32 with 95% CI of 1.50–3.47 [Figure 3].

Downloaded from http://journals.lww.com/ijph by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC4/OAVpDDa8KKGKV0Ymy+78= on 07/04/2024

Meta-analysis of alcohol with oral cavity cancer risk

Oral cancer is the one of the most common cancers in India. Therefore, to see the effect of alcohol on oral cavity cancer, we selected 7 Indian studies which only analyzed relation of alcohol and oral cancer, leading to screening of 4471 cases and 6768 controls. Pooled OR of 1.92 (95% CI: 1.44–2.96) was found; in other words, alcohol had 2 times more risk of oral cancer among drinkers as compared to nondrinkers after adjusting for other factors [Figure 4]. We excluded analysis of the other subsites as there was not enough literature available on specific subsites (more than 5 studies).

Heterogeneity test and subgroup analysis

We used "metafor" package available in R3.5.1 software to perform the heterogeneity inspection for the study type, sample group, and region; we estimated whether the study populations

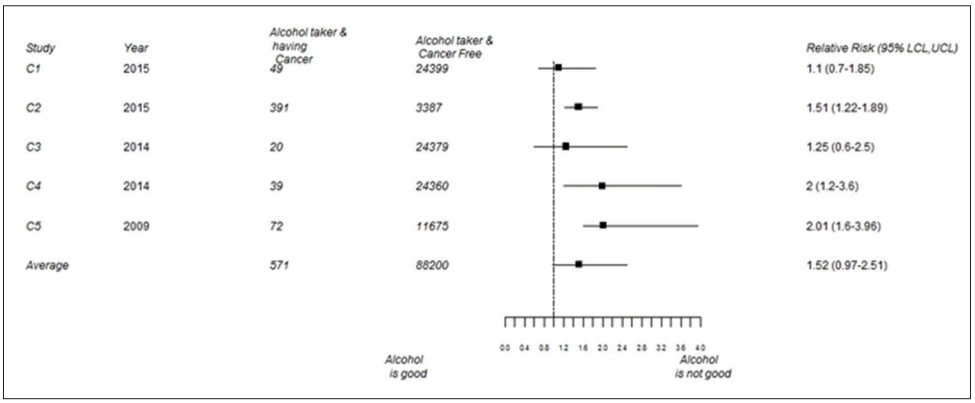

Figure 2: Forest plot showing pooled relative risk of Alcohol causing cancer in cohort studies.

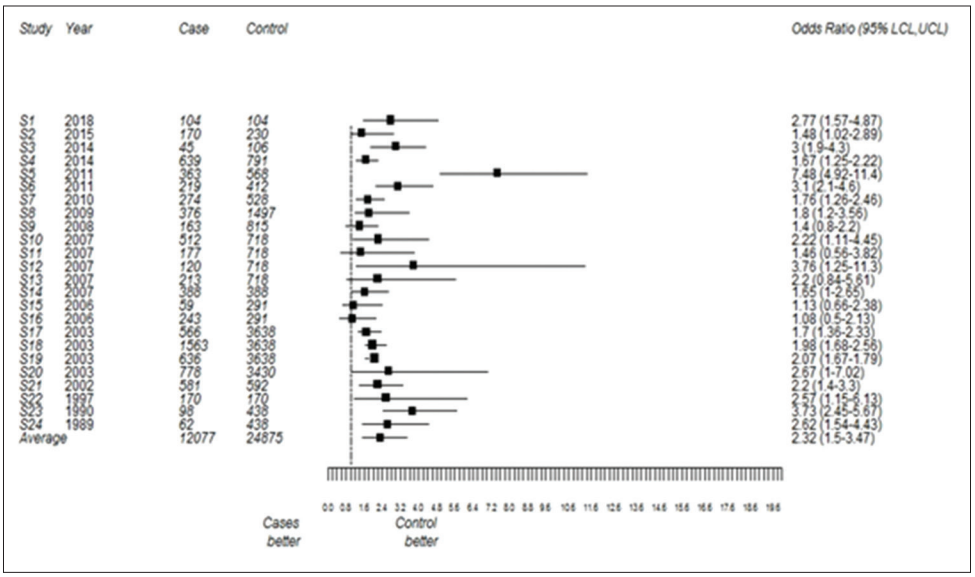

Figure 3: Forest plot of pooled odds ratio of case–control studies of alcohol causing cancer.

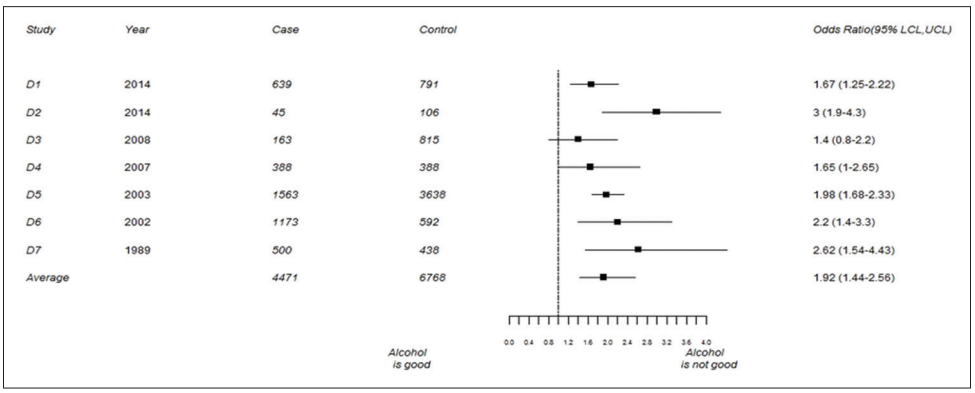

Figure 4: Forest plot of pooled odds ratio of case–control studies of alcohol causing oral cavity cancer.

had homogeneity. We applied hypothesis testing to examine whether the heterogeneity of multiple independent studies have statistically significant differences. We found that statistically significant heterogeneity in studies with heterogeneity test showed $P < 0.001$ and $I^2 = 92\%$. The large heterogeneity suggests that the data were truly representative of our entire population.

Downloaded from http://journals.lww.com/ijph by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC4/OAVpDDa8KKGKV0Ymy+78= on 07/04/2024

Discussion

Alcohol consumption is estimated to be the third most important modifiable risk factor for death and disability worldwide.[1] In India, almost 1 lakh deaths that occur on Indian roads every year are indirectly related to alcohol abuse. Although liver cirrhosis is the biggest health problem posed by alcohol use, with 1.4 lakh deaths every year, another 30,000 deaths among cancer patients can be traced to alcohol use.[1]

Carcinogenic mechanism

The IARC has listed both ethanol and its major metabolite, acetaldehyde, as a carcinogen in humans.[5] The mechanisms by which alcohol consumption exerts its carcinogenic effect are various and not fully understood. Acetaldehyde, the first metabolite of ethanol, is accountable for part of the carcinogenicity of alcohol drinking on the liver and the upper aerodigestive tract.[6] Polymorphisms of the genes that encode enzymes for ethanol metabolism affect the ethanol/acetaldehyde-oxidizing capacity and are responsible for the limited action of the enzyme that converts acetaldehyde (carcinogens) to acetate that is not toxic to the body.[7-9] Alcohol is responsible for high estrogen and androgen levels in women that might promote the development of breast cancer[10] or the alcohol-related immunodeficiency and immunosuppression that might facilitate carcinogenesis at various organs.[11] In addition, ethanol-related folate malabsorption and deficiency are associated with different forms of cancer, of which colon cancer is the most commonly described.[12] Finally, alcohol may cause direct lesions to the epithelium of the upper digestive and respiratory tract and favor the absorption of carcinogens.[13]

Alcohol: How India is different from rest of the World?

Alcohol drinking in India is different from the Western world. According to global status health report on alcohol, India (3 l/year) has relatively low consumption of pure alcohol as compared to Belarus (14.4 l/year) and France (11.8 l/year). Confused reporting of the unit drink (60–270 ml) in India as compared to universally followed unit of 30 ml (12 g of ethanol ~30 ml of spirits at 42.8% v/v/330 ml of 5% v/v beer) makes the contribution of unrecorded consumption significant. Pattern of drinking is also diverse in India. It is amongst the lower consuming country but Indian drinker's follows "all or none"phenomenon which means high proportion of drinkers, drink greater volume on a single occasion. An extensive study on alcohol and harm conducted across five cities in India reveals that majority of the drinker consume alcohol empty stomach, thus making them preposterous to toxicity of alcohol. Not only the pattern but also the type of alcohol consumed is unique. Spirits (92%) form the major proportion of the total consumption of pure alcohol in India. Our country has been witnessing incidences of methanol contamination in traditional beverages, leading to methanol-related fatalities. Alcohol is distinctively consumed in India in relation to frequency, quantity, quality, pattern, type, and contamination, thus making India a unique subset as compared to the rest of the world to study the carcinogenic effects of alcohol.

Therefore, we did the present study, based on the results published in 29 studies. It represents the most up-to-date, exhaustive, and comprehensive review on the association between alcohol and cancer on the Indian studies. RevMan 5.0(https://training.cochrane.org) and R 3.5.1(https://cran.r-project.org/) software to analyze the data. In order to make it study-wise representation, we divided our study group into cohort and case–control studies. The combined effect quality OR for ever drinker for case–control Indian studies was 2.32 with 95% CI (1.50–3.47). Our results demonstrated that alcohol consumption significantly increases the risk of cancer. Meta-analysis of five cohort studies showed 1.5 times more chances of developing cancer in alcohol consumers as compared to nonusers. The meta-analysis of 24 case-control studies is observed with pooled odds risk of 2.3 times for alcohol consumers. Thus, case–control studies reported a stronger association of alcohol and cancer as compared with cohort studies. Further, we analyzed relationship specifically between oral cavity cancer and alcohol drinkers as it is one of the most common life-threatening malignancies in India. However, whether drinking alcohol can cause oral cavity cancer has been inconsistently reported in Indian studies. In this study, we present a meta-analysis of the literature published over the past 40 years on the role of alcohol drinking related to the development of cancer and a special focus has been given on its relation in causation of oral cavity cancer. Thus, we calculated the collective effect quantity OR for oral cavity cancers for alcohol in Indian case–control studies. The combined effect OR was 1.92 with 95% CI (1.44–2.96). This result concluded that alcohol independently increases the risk of oral cavity cancers. There was significant heterogeneity among the studies, thus representing different population groups.

There is ample evidence in the international literature on association of alcohol consumption with overall cancer. However, its correlation is lacking in Indian studies. We also do not have amount of alcohol and cancer occurrence. Through our search strategy, we found two Indian studies analyzing the effect of alcohol on lung cancer, having odds of 3.1 and 2.67.[19,27] Similarly, there were three studies defining the carcinogenic effect of alcohol on laryngeal and hypopharyngeal cancers.[23,26,30] All these studies had OR ranging from 1.65 to 3.76. We discovered three studies stating cancer-causing effect of alcohol on esophageal cancer. When adjusted for the confounding factors, OR ranged from 1.7 to 2.5.[21,26,29] Phukan identified consumption of alcoholic beverages to be an important risk factor for hepatocellular carcinoma (OR: 2.77, 95% CI: 1.02–4.95).[14] A Delhi-based study considered current usage of alcohol to be important risk factor for prostate carcinogenesis (OR: 1.76, 95% CI: 1.26–2.76). Wang *et al*. concluded that the consumed alcohol (gram-years) may be associated with colon or rectal risk.[25] Thus, there are few studies in Indian literature concluding the carcinogenic potential of alcoholic beverages on larynx, hypopharynx, buccal[31], esophagus, liver,

colorectal, and prostate. However, our meta-analysis proves alcohol to have definite effect on overall cancer.

Our study has several limitations typical of meta-analyses of observational studies. The first one is that heterogeneity across studies was high; therefore, even if we used random effects models to take heterogeneity into account and performed several heterogeneity analyses, some of the estimates should be interpreted with caution. A second limitation is that we could not investigate the role of different drinking patterns and different types of beverages in modifying the effect of the total amount of alcohol consumed. Another problem regarding misclassification is the possible inclusion of former drinkers in the nondrinkers' category, as patients with preclinical cancer symptoms might tend to stop drinking more frequently than healthy individuals, thus diluting the risk of cancer among drinkers. Heterogeneity among studies with regard to the approaches used to measure alcohol consumption, modalities of interview, and measures to ensure confidentiality, together with the lack of beverage-specific analyses, represent other limitations of our study. However, this study contradicts any beneficial effect of alcohol defending its potential for carcinogenesis.

Conclusions

This meta-analysis concluded that the consumption of alcoholic beverages increases the overall risk of cancer in India and more specifically alcohol consumption nearly doubles the risk of oral cavity cancers.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. WHO. Alcohol. Available from: http://www.who.int/substance_ab use/publications/alcohol/en/. [Last accessed on 2017 Aug 15].
2. Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-Tieulent J, Jemal A. Global cancer statistics, 2012. CA Cancer J Clin 2015;65:87-108.
3. Bray F, Soerjomataram I, Mery L, Ferlay J. Improving the quality and coverage of cancer registries globally. Lancet 2015;386:1035-6.
4. Bagnardi V, Rota M, Botteri E, Tramacere I, Islami F, Fedirko V, *et al*. Alcohol consumption and site-specific cancer risk: A comprehensive dose-response meta-analysis. Br J Cancer 2015;112:580-93.
5. Meadows GG, Zhang H. Effects of alcohol on tumor growth, metastasis, immune response, and host survival. Alcohol Res 2015;37:311-22.
6. Boffetta P, Hashibe M. Alcohol and cancer. Lancet Oncol 2006;7:149-56.
7. Seitz HK, Stickel F. Molecular mechanisms of alcohol-mediated carcinogenesis. Nat Rev Cancer 2007;7:599-612.
8. Pöschl G, Seitz HK. Alcohol and cancer. Alcohol Alcohol 2004;39:155-65.
9. Wang Y, Xu M, Ke Z, Luo J. Cellular and molecular mechanism underlying alcohol-induced aggressiveness of breast cancer. Pharmacol Res 2017;115:299-308.
10. Al-Sader H, Abdul-Jabar H, Allawi Z, Haba Y. Alcohol and breast cancer: The mechanisms explained. J Clin Med Res 2009;1:125-31.
11. Watson RR, Borgs P, Witte M, McCuskey RS, Lantz C, Johnson MI, *et al*. Alcohol, immunomodulation, and disease. Alcohol Alcohol 1994;29:131-9.
12. Hamid A, Wani NA, Kaur J. New perspectives on folate transport in relation to alcoholism-induced folate malabsorption–association with epigenome stability and cancer development. FEBS J 2009;276:2175-91.
13. Doll R, Peto R, Hall E, Wheatley K, Gray R. Mortality in relation to consumption of alcohol: 13 years' observations on male British doctors. BMJ 1994;309:911-8.
14. Phukan RK, Borkakoty BJ, Phukan SK, Bhandari K, Mahanta J, Tawsik S, *et al*. Association of processed food, synergistic effect of alcohol and HBV with Hepatocellular Carcinoma in a high incidence region of India. Cancer Epidemiol 2018;53:35-41.
15. Singh SA, Choudhury JH, Kapfo W, Kundu S, Dhar B, Laskar S, *et al*. Influence of the CYP1A1 T3801C polymorphism on tobacco and alcohol-associated head and neck cancer susceptibility in Northeast India. Asian Pac J Cancer Prev 2015;16:6953-61.
16. Madani AH, Dikshit M, Bhaduri D, Aghamolaei T, Moosavy SH, Azarpaykan A. Interaction of alcohol use and specific types of smoking on the development of oral cancer. Int J High Risk Behav Addict 2014;3:e12120.
17. Anantharaman D, Chabrier A, Gaborieau V, Franceschi S, Herrero R, Rajkumar T, *et al*. Genetic variants in nicotine addiction and alcohol metabolism genes, oral cancer risk and the propensity to smoke and drink alcohol: A replication study in India. PLoS One 2014;9:e88240.
18. Sharma MK, Gour N, Pandey A, Wallia D. Epidemiological study of risk factors for oral, laryngeal and esophageal cancers at a tertiary care hospital in India. Asian Pac J Cancer Prev 2011;12:1215-8.
19. Ganesh B, Sushama S, Monika S, Suvarna P. A case-control study of risk factors for lung cancer in Mumbai, India. Asian Pac J Cancer Prev 2011;12:357-62.
20. Tyagi B, Manoharan N, Raina V. A case control study on prostate cancer in Delhi. Asian Pac J Cancer Prev 2010;11:397-401.
21. Ganesh B, Talole SD, Dikshit R. Tobacco, alcohol and tea drinking as risk factors for esophageal cancer: A case-control study from Mumbai, India. Cancer Epidemiol 2009;33:431-4.
22. Muwonge R, Ramadas K, Sankila R, Thara S, Thomas G, Vinoda J, *et al*. Role of tobacco smoking, chewing and alcohol drinking in the risk of oral cancer in Trivandrum, India: A nested case-control design using incident cancer cases. Oral Oncol 2008;44:446-54.
23. Sapkota A, Gajalakshmi V, Jetly DH, Roychowdhury S, Dikshit RP, Brennan P, *et al*. Smokeless tobacco and increased risk of hypopharyngeal and laryngeal cancers: A multicentric case-control study from India. Int J Cancer 2007;121:1793-8.
24. Subapriya R, Thangavelu A, Mathavan B, Ramachandran CR, Nagini S. Assessment of risk factors for oral squamous cell carcinoma in Chidambaram, Southern India: A case-control study. Eur J Cancer Prev 2007;16:251-6.
25. Wang J, Gajalakshmi V, Jiang J, Kuriki K, Suzuki S, Nagaya T, *et al*. Associations between 5,10-methylenetetrahydrofolate reductase codon 677 and 1298 genetic polymorphisms and environmental factors with reference to susceptibility to colorectal cancer: A case-control study in an Indian population. Int J Cancer 2006;118:991-7.
26. Znaor A, Brennan P, Gajalakshmi V, Mathew A, Shanta V, Varghese C, *et al*. Independent and combined effects of tobacco smoking, chewing and alcohol drinking on the risk of oral, pharyngeal and esophageal cancers in Indian men. Int J Cancer 2003;105:681-6.
27. Gajalakshmi V, Hung RJ, Mathew A, Varghese C, Brennan P, Boffetta P. Tobacco smoking and chewing, alcohol drinking and lung cancer risk among men in Southern India. Int J Cancer 2003;107:441-7.
28. Balaram P, Sridhar H, Rajkumar T, Vaccarella S, Herrero R, Nandakumar A, *et al*. Oral cancer in southern India: The influence of smoking, drinking, paan-chewing and oral hygiene. Int J Cancer 2002;98:440-5.
29. Srivastava M, Kapil U, Chattopadhyay TK, Shukla NK, Sundaram KR, Sekaran G, *et al*. Nutritional factors in carcinoma oesophagus: A case-control study. Asia Pac J Clin Nutr 1997;6:96-8.
30. Sankaranarayanan R, Duffy SW, Nair MK, Padmakumary G, Day NE. Tobacco and alcohol as risk factors in cancer of the larynx in Kerala, India. Int J Cancer 1990;45:879-82.
31. Sankaranarayanan R, Duffy SW, Padmakumary G, Day NE, Krishan Nair M. Risk factors for cancer of the buccal and labial mucosa in Kerala, Southern India. J Epidemiol Community Health 1990;44:286-92.

Annexure Table 1 is available in online version

Downloaded from http://journals.lww.com/ijph by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC4/OAVpDDa8KKGKV0Ymy+78= on 07/04/2024

Downloaded from http://journals.lww.com/ijph by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC4/OAVpDDa8KKGKV0Ymy+78= on 07/04/2024

Annexure Table 1: Adjusted Indian studies considered in the meta-analysis relating alcohol to cancer

Serial number	First author	Years	Association	Classification of drinking	Diagnosis	Confounding factors
S01	Phukan[14]	2018	2.77	Current and never	Hepatocellular carcinoma	Educational status Occupational status Location of residence Drinking habits
S02	Singh[15]	2015	1.48	Never, light, heavy	Head and neck cancer	Smoking Betal-quid chewing Smoking+betal quid chewing Alcohol+smoking Alcohol+tobacco betal quid chewing Alcohol+smoking+tobacco betal quid chewing
S03	Madani[16]	2014	3.00	Current and never	Oral cancer	Filtered cigarette Non filtered cigarette Bidi
S04	Anantharaman[17]	2014	1.67	Ever and never	Head and neck cancer	Years of education Tobacco use
S05	Sharma[18]	2011	7.48	Current and never	Upper aero digestive tract cancers	Tobacco Smoking
S06	Ganesh[19]	2011	3.1	Current and never	Lung cancer	Cigarette smoking Bidi smoking Tobacco chewing Fish consumption Chicken consumption Red meat consumption Vegetable consumption Chilly consumption Milk Tea Coffee Citrus fruits Fresh fruits Family history Cotton dust Diesel gas Pesticide
S07	Tyagi[20]	2010	1.76	Current and never	Prostate cancer	Bidi smoking Cigarette with filter Cigarette without filter Tea Eggs Chicken Mutton Fish Pulses Orange Melon Sunflower oil Other oils Vitamins
S08	Ganesh[21]	2009	1.8	Ever and never	Esophageal cancers	Pan with tobacco Tobacco alone Bidi Cigarette
S09	Muwonge[22]	2008	1.4	Current former and never	Oral cancer	Education Religion Chewing tobacco

Contd...

Annexure Table 1: Contd...

Serial number	First author	Years	Association	Classification of drinking	Diagnosis	Confounding factors
S10	Sapkota[23]	2007	2.22	Daily	Hypophayrnx	Centre Age Sex SEA Tobacco snuffing Tobacco chewing
S11	Sapkota[23]	2007	1.46	Daily	Glottis	Centre Age Sex SEA Tobacco snuffing Tobacco chewing
S12	Sapkota[23]	2007	3.76	Daily	Supraglottis	Centre Age Sex SEA Tobacco snuffing Tobacco chewing
S13	Sapkota[23]	2007	2.2	Daily	Larynx	Centre Age Sex SEA Tobacco snuffing Tobacco chewing
S14	Subapriya[24]	2007	1.65	Current and never	Oral cancer	Age Sex Religion Diet Oral hygiene Literacy Occupation
S15	Wang[25]	2006	1.13	Current and never	Colonal cancer	Age Sex Income Education Religion Mother tongue Tobacco Chewing habit Vegetarianism
S16	Znaor[26]	2003	1.70	Ever and never	Esophageal	Age Centre Level of education
S17	Znaor[26]	2003	1.98	Ever and never	Oral cavity	Age Centre Level of education
S18	Znaor[26]	2003	2.07	Ever and never	Pharynx	Age Centre Level of education

Contd...

Downloaded from http://journals.lww.com/ijph by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC4/OAVpDDa8KKGKV0Ymy+78= on 07/04/2024

Annexure Table 1: Contd...

Serial number	First author	Years	Association	Classification of drinking	Diagnosis	Confounding factors
S19	Wang[25]	2006	1.08	Current and never	Rectal cancer	Age Sex Income Education Religion Mother tongue Tobacco Chewing habit Vegetarianism
S20	Gajalakshmi[27]	2003	2.67	Current. Former and never	Lung cancers (Indian alcohol)	Age Education Centre
S21	Balaram[28]	2002	2.2	Current. Former and never	Oral cancers	Age Gender Education Centre Chewing habits
S22	Srivastava[29]	1997	2.57	Ever and never	Esophagus	Age Sex SEA
S23	Sankaranarayanan[30]	1990	3.73	Ever and never	Laryngeal cancers	Religion Age Pan Bidi Cigarette Snuff
S24	Sankaranarayanan[31]	1989	2.62	Ever and never	Gingival cancers	Age Pan Bidi Cigarette Snuff

SEA: Socioeconomic status

Downloaded from http://journals.lww.com/ijph by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC4/OAVpDDa8KKGKV0Ymy+78= on 07/04/2024