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Alcoholic beverage preference and dietary habits: a systematic literature review

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Abstract

Introduction: The aim of this review is to systematically and critically evaluate the existing literature into the association between alcoholic beverage preference and dietary habits in adults.

Methods: A literature search was conducted in the databases of Medline (Pubmed), ISI Web of Knowledge, and PsycINFO for studies published up to March 2013. From a total of 4,345 unique hits, 16 articles were included in this systematic review. Two independent reviewers extracted relevant data for each study and assessed study quality.

Results: 14 cross-sectional and 2 ecological studies from the United States and several European countries were included. Across different study populations and countries, persons with a beer preference displayed in general less healthy dietary habits. A preference for wine was strongly associated with healthier dietary habits in Western study populations, whereas studies in Mediterranean populations did not observe this. Dietary habits of persons with another preference or who were abstinent were less reported.

Conclusion: This review has shown that the preference for a specific alcoholic beverage is associated with diet. Thus, it might not be the alcoholic beverage but the underlying dietary patterns that are related to health outcomes.

Introduction

The relationship between alcohol and cardiovascular diseases is assumed to be J-shaped. Several studies have reported differential effects of alcoholic beverages in the protection against cardiovascular disease, mostly in favour of wine consumption¹⁻³. However, a recent meta-analysis indicated that moderate consumption of both wine and beer could reduce the risk for cardiovascular diseases⁴.

Moreover, beer consumption is commonly believed to induce a so-called "beer belly"⁵⁻⁷, but a recent systematic review and meta-analysis on the relationship between beer consumption and abdominal obesity concluded that there is inadequate scientific evidence to state that beer intake at moderate levels is associated with general or abdominal obesity⁸.

It has been suggested that the observed differences in association between wine, beer, and spirits and mortality might be due to the dietary habits associated with the preference and consumption of these beverages. Although most studies investigating the relationship between drinking patterns and lifestyle have focused on alcohol consumption in general⁹⁻¹¹, several studies looked specifically at alcoholic beverage preference and diet. The aim of this review is to systematically and critically evaluate the existing literature into the association between alcoholic beverage preference and dietary habits in adults.

Methods

Protocol

This review was prepared in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines^{12, 13}.

Eligibility criteria

In this narrative systematic review, published studies in peer- or editorial-reviewed journals were included; grey literature was not explored. All study designs were included in the review. Studies were considered eligible for inclusion when the population consisted of adults, when alcoholic beverage types (consumption or preference) were the exposure and habitual diet (food or nutrient intake or overall diet) was an outcome measure. No definition of alcoholic beverage preference exists. Therefore, all studies were that have assessed preference as the most chosen or consumed beverage and studies that have assessed wine, beer, or spirit consumption separately independent from whether this was the preferred beverage. Furthermore, all studies where nutrient intake, food group intake, or adherence to dietary patterns and indexes was an outcome measure were included. No restrictions with respect to study population were made, but studies in alcoholics and hospitalized patients with diseases or treatments associated with diet were excluded.

Literature search and article selection

A literature search was conducted in the databases of Medline (Pubmed), ISI Web of Knowledge, and PsycINFO for studies published up to July 2012. These databases were selected because they were believed to include all eligible literature based on their scientific focus: Medline includes peer-reviewed literature in biomedical and life sciences, ISI Web of Knowledge in general science, social sciences, and arts and humanities, and PsycINFO focuses on behavioural sciences and mental health. Used search strings were: #1: alcohol AND (preference OR beverage) AND (diet OR nutrition) and #2: (wine OR beer OR spirits OR liquor)

AND (diet OR nutrition). The flow-chart of the systematic literature search and reasons for exclusion is shown in **Figure 1**. The Medline search gave 2,674 hits, the search of ISI Web of Knowledge 2,525 and the search of PsycINFO 345 hits, corresponding to a total of 4,345 unique hits. Two reviewers (DS and RB) independently selected the articles and any discrepancies between them were solved by consensus. Based on title and abstract, 50 articles were retrieved for full-text review. Of these, 37 papers were excluded due to the following reasons: written in another language than mastered by any of the authors¹⁴⁻¹⁹, duplicate publication²⁰, no original data²¹⁻²³, study population did not fulfil inclusion criteria (animals, alcoholics)²⁴⁻²⁷, alcohol consumption was not specified into beverage type or preference^{9, 28-34}, diet was not the studied outcome^{7, 35-41}, or both exposure and outcome did not match the inclusion criteria⁴²⁻⁴⁷, and one article could not be retrieved⁴⁸. Thus, 13 articles were included in the review. Manual screening of the reference lists of the articles yielded 2 more eligible articles^{49, 50}, resulting in the inclusion of 15 articles⁴⁹⁻⁶³. Before submitting the manuscript, the literature search was updated with studies published from July 2012 to March 2013. This resulted in the inclusion of one other study⁶⁴. Finally, a total of 16 articles were included in this systematic review.

Data extraction

One reviewer extracted the data (DS), the other checked (RB). For each study, the following relevant data were extracted: first author, year of publication, study name, country of study population, number of participants, assessment method of alcohol consumption, definition of alcoholic beverage preference, dietary assessment method, adjustments, and the most important results.

Quality assessment

Because no valid quality assessment tool for cross-sectional or ecological studies is available, we developed a standardised quality assessment form specifically for this review. This assessment tool was based upon key methodological points to consider in the appraisal of cross-sectional studies formulated by Young and Solomon⁶⁵ and the Newcastle-Ottawa Scale for assessing the quality of nonrandomised studies in meta-analyses⁶⁶. We appraised the quality of each study using a 5-star system, including appraisal of external and internal validity and biases relevant to observational studies in general, and specific to beverage preference and diet. Two reviewers (DS and RB) independently evaluated study quality and differences were resolved by consensus.

Summary measures

Results from the included studies will be discussed on the outcome levels of nutrient intake, food intake, and overall diet quality. In addition, if available, outcomes of non-consumers were included.

Results*General characteristics included studies*

Table 1 shows general characteristics of the 14 cross-sectional and 2 ecological studies included in the review. In the ecological studies, adult-only households and supermarket transactions were studied rather than individuals^{55, 56}. In the cross-sectional studies, number of subjects varied between 423⁶⁴ and 48,763⁶² and were performed in Spain^{51, 53, 61, 63}, United States^{49, 50, 52, 58}, Denmark^{56, 62}, Finland⁵⁷, United Kingdom⁵⁵, Italy⁵⁴, and France^{59, 60, 64} between 1997 and 2012. Alcoholic beverage preference was mostly defined as an intake of the preferred beverage constituting at least 50% of the total reported alcohol consumption^{51-53, 57, 62, 64}. Cut-off points of 70% to 75%^{58, 60} were applied as well. Moreover, three studies did not define preference but assessed absolute consumption of different alcoholic beverages^{49, 59, 61} and another assessed preference with a direct question⁵⁰. The ecological studies defined beverage preference based on purchases^{55, 56} and in two studies the definition was not elaborated^{54, 63}.

In seven studies, nutrient intakes across beverage preference categories were reported^{51, 52, 57-60}, intake on food group level in nine studies^{51-54, 58, 60, 62, 64}, and eight reported on diet in general, including adherence to dietary guidelines⁶³, dietary patterns^{61, 64} and diet quality indexes^{49, 53, 60}. The ecological studies used expenditure on food items as an outcome^{55, 56}.

Study quality, as assessed with our own quality assessment scale, ranged from 3⁴⁹ to 8^{57, 60, 62, 63} out of a maximum of 8 stars (**Table 2**). **Table 3** schematically displays the major results from the included studies, which will be discussed in more detail below.

Alcoholic beverage preference

Alcoholic beverage preferences ranged across studies. In four studies from Denmark, United States, and Finland, the largest proportion of women preferred wine and the largest proportion of men preferred beer^{52, 57, 62}. In France, Italy, and Spain, the majority had a wine preference^{51, 53, 54, 59, 60}, with the exception of Valencia-Martín *et al.*, where 65% of the Spanish study population was classified as having no specific preference⁶³.

Beer preference

Across different study populations and countries, persons with a beer preference displayed in general less healthy dietary habits.

In the Expenditure and Food Survey 2005-2006 in the United Kingdom, households preferring beer or spirits, spent 12% of the budget on healthy foods, compared to 18% of the households preferring wine⁵⁵. According to supermarket transactions in Denmark, beer buyers bought less fruits and vegetables, but more unhealthy products, including soft drinks, meat, and fats⁵⁶. Furthermore, beer and ale consumption was inversely associated with the Healthy Eating Index in a U.S. food survey⁴⁹. Another study in American adults showed persons who preferred beer had the lowest intake of fruit, juices, and vegetables⁵⁸. In addition, Männistö *et al.* observed that

Finnish women who preferred beer had the highest energy intake from saturated fat and sugar compared with other preference groups⁵⁷.

Similar associations were observed in Mediterranean populations. Valencia-Martín *et al.* (Spain) showed that beer drinkers less often adhered to the guidelines on intake of fruit and vegetable, meat, fish, and eggs compared with no preference⁶³. Sánchez-Villegas and co-workers (Spain) showed that those who consumed more beer less adhered to a Western as well as a Mediterranean dietary pattern⁶¹. In France, persons with a beer preference had the highest intake of energy, fat, and carbohydrates, high-fat meat and potatoes compared with other preference groups⁶⁰ and the highest energy intake from snacks⁵⁹.

Wine preference

For wine preference, a contrast was observed between Western (i.e. Northern-European and U.S.) and Mediterranean populations. A preference for wine was strongly associated with healthier dietary habits in Western study populations, whereas studies in Mediterranean countries, including Italy and Spain, did not observe this.

In a large Danish sample, it was seen that wine preference was associated with a higher consumption of fruit, vegetables, fish, salads and olive oil compared with a beer or spirit preference⁶². Barefoot *et al.* also observed that persons from the U.S. with a wine preference had the highest intakes of fruit, vegetables, and dietary fibre⁵². Paschall and Lipton observed that U.S. wine consumers were more likely to be vegetarian and consumed less fast food⁵⁰. Furthermore, wine consumption was positively associated with the Healthy Eating Index in a U.S. food survey⁴⁹ and consumption of fruit, juices, vegetables and grain in another U.S.

sample⁵⁸. Männistö *et al.* observed that Finnish persons who preferred wine had a higher intake of energy from protein, vitamin C⁵⁷, and in the study of McCann *et al.* (U.S.), wine consumers had high intakes of carbohydrates, protein, fibre, potassium, folate, vitamin C, and carotenoids⁵⁸. In the U.K., it was seen that households preferring wine spent 18% of the budget on healthy foods, also when stratified by income, which was respectively 6 percentage points and 5 percentage points more of the budget than households preferring beer and spirits⁵⁵. In Denmark, wine buyers were more likely to buy oil, olives, veal and beef than those who bought beer or both wine and beer⁵⁶.

Studies in Southern-European populations did not show such strong associations between wine preference and a healthy diet. Whereas Sánchez-Villegas and co-workers (Spain) reported that those who adhered more to a Mediterranean dietary pattern, consumed more wine⁶¹, Carmona-Torre *et al.* detected only small differences in dietary intake⁵³. In general wine consumers displayed no significant healthier or unhealthier dietary habits compared with other preference groups⁵³. Chatenoud *et al.* also did not detect any significant associations between Italian wine drinkers and indicators of a healthy diet, including intake of fruit, vegetables, and fish⁵⁴. Furthermore, in the study of Alcácer *et al.* (Spain) no large differences in adherence to the Mediterranean diet existed between preference groups⁵¹. Herbeth *et al.* demonstrated that alcoholic beverage preference was not associated with differences in food group intake or adherence to diet patterns in French men⁶⁴.

Spirit preference

The prevalence of spirit preference was lower compared to the other preference categories.

Although the dietary intakes of persons for whom spirits were the preferred beverage are less reported in literature, these persons displayed less healthy dietary habits in both Western and Mediterranean populations.

In the study of Barefoot *et al.* (U.S.), spirit preference was associated with the highest intake of red and fried meats, cholesterol and in men the highest absolute alcohol intake⁵². Moreover, British households preferring spirits spent the largest proportion on unhealthy foods⁵⁵. In Finland, men with a spirit preference displayed the highest intakes of energy from fat, saturated fat and protein⁵⁷. The same was seen by McCann *et al.* in the U.S., where spirit preference was associated with a high intake of total and saturated fat, meat, and dairy⁵⁸. Furthermore, in another U.S. study, persons with spirit preference were less likely to follow a vegetarian diet⁵⁰. Next, a preference for spirits was in Spain associated with a lower adherence to dietary guidelines for fruit and vegetable intake⁶³ and a lower adherence to the Mediterranean diet⁶¹. Alcácer *et al.* showed that Spanish persons preferring spirits had the highest food-derived energy intake and a higher intake of energy from lipids⁵¹.

No preference

As with spirit preference, dietary habits of persons without a specific preference for alcoholic beverage were less reported. Furthermore, the dietary habits of persons with no preference were very heterogeneous and ranged across studies. Having no specific preference could not be linked to specific dietary habits.

Non-consumers

Although the association of alcohol abstinence and dietary habits were not the main objective of this systematic review, some studies reported on dietary habits among non-consumers. By and large, non-consumers displayed healthy dietary habits, comparable to persons with a preference for wine, but were also more likely to be overweight.

Barefoot *et al.* (U.S.) observed that female non-consumers had a high fibre intake⁵². Moreover, Finnish abstainers reported the highest energy intake from carbohydrates⁵⁷. Next, in Denmark, abstainers reported low intakes of fish, vegetables, and salad⁶². Paschall and Lipton made a distinction between lifetime abstainers and former alcohol consumers in the U.S., where former consumers had a high fast-food consumption, and lifetime abstainers reported the highest subjective health⁵⁰. Alcácer and co-workers observed that Spanish non-consumers had a higher carbohydrate and fibre intake⁵¹. In the study of Rouillier *et al.*, French non-consumers had the highest energy intake at breakfast⁵⁹.

Discussion*Summary of findings*

This narrative systematic review shows that alcoholic beverage preference is related to specific dietary habits depending on living area. Persons with a wine preference had in general healthier dietary habits than persons with other preferences; this was mainly observed in Western countries and to a lesser extent in Mediterranean countries. Those who preferred beer and spirits displayed less healthy dietary habits, both in Western and Mediterranean countries.

*Explanation association alcoholic beverage preference and diet*Potential health benefits of wine

Several explanations can be thought of why persons with a wine preference had healthier dietary habits. First, persons with a healthy dietary behaviour might be more inclined to choose wine because more health benefits might be attributed to drinking wine as opposed to other alcoholic beverages. Wine is believed to contain beneficial components such as polyphenols and to have positive effects on cholesterol levels and cardiovascular risk⁶⁷.

Overall drinking pattern

Second, wine may be part of an overall healthy alcohol drinking pattern, since it is most often consumed during meals and in smaller amounts, whereas beer and spirits are more often used for heavy (binge) drinking^{1,68}, but not necessarily so³⁷. An unhealthy drinking pattern has shown to be accompanied by unhealthy dietary habits⁶⁹. This is also illustrated by the results of the study of Valencia-Martin *et al.* showing binge drinking is associated to less adherence to dietary guidelines⁶³. Other studies also reported that heavy drinking was related to a lower intake of dietary fibre, fruit and vegetables^{60, 62, 63}. When the underlying drinking pattern and the absolute alcohol intake are not taken into account, they can confound the association between alcoholic beverage preference and diet.

Cultural, social, and demographic factors

Third, persons who prefer wine are in general older, female, smoke less, and have a higher socioeconomic status; these factors are also strong determinants of health behaviours. We have shown that alcoholic beverage preference and diet are both determined by region, culture, but also by

age, gender, and socio-economic status. In Western countries, wine is in general more expensive than beer; as a result, persons with a larger income are more likely to purchase wine. On the other hand, wine is the most common type of alcoholic beverage in Mediterranean countries such as Italy and Spain and is consumed by all walks of life, since it is economically affordable for all social classes. Because the association between wine preference and a healthy diet was particularly pronounced in Western countries, it is most likely that socio-economic status is the underlying explaining factor of this health behaviour.

Limitations

This systematic review has some limitations which should be taken into account when interpreting the results. Because the included studies have a cross-sectional or ecological study design, it is hard to conclude whether the relationship between beverage preference and dietary habits is causal. However, the main objective of the included studies was not to assess causality, but to investigate whether the habits were associated. Furthermore, recall bias could be introduced when wine drinkers are more aware of a healthy diet and reporting a higher intake of these items. Differential beverage-specific reporting bias of absolute alcohol consumption by high and low consumers may be present, but reporting bias with regard to the type of alcoholic beverage does not appear to be a problem in most population studies⁷⁰.

Although a large amount of studies have investigated the association between alcohol consumption and diet, many did not specify into beverage type. The number of included studies allowed us to formulate some general conclusions, but studies were predominantly performed in Europe and the United States. We could observe differences between Western European and Mediterranean countries, but it is not known whether the results are applicable to Eastern European, Asian, African, or Southern-American countries. Furthermore, no definition of alcoholic beverage preference exists. Only six out of 16 studies used the same definition, namely the preferred beverage was the (self-reported) drink that accounted for >50% of the total number of standard units of alcohol consumed. Moreover, some considered absolute intake of a specific alcoholic beverage as a measure of preference. In addition, a wide range of dietary factors was included as outcome measure. Because of this heterogeneity in exposure and outcome variables, it was not possible to perform a meta-analysis. Because we could not conduct a meta-analysis,

we could not quantify potential publication bias with a funnel plot. We can, however, speculate on the subject. There were more studies included in the review that did find associations than studies that did not find any relationship. Therefore, if publication bias was present, we probably have overestimated the association between alcohol preference and diet.

Study quality was assessed with a scale we developed ourselves because no valid appropriate quality assessment tool exists. Since the quality assessment was therefore not completely objective, we have not excluded any study from the review because of too low quality. The quality of the included studies ranged from 3 to 8 out of 8 studies; a majority of the studies scored very high (7 or 8 points). We considered 7 of 16 studies to be performed in a sample representative of that country. To our judgment, two studies did not assess alcohol and diet with a valid measure; Johansen *et al.* based diet on supermarket transactions only and Paschall and co-workers asked only two questions on diet^{50, 56}. Furthermore, two studies did not report which definition of alcoholic beverage preference was used^{49, 54}. The studies with ecological design scored lower than the cross-sectional studies. Moreover, the studies that scored low in the critical appraisal did not adjust for important confounders such as age, sex, and SES. Because both exposure and outcome are related to these factors, it might be that these studies have overestimated the association between alcoholic beverage preference and diet.

Recommendations for future research on alcoholic beverage preference and diet

Based on the results of this review, it would be valuable to perform an observational study among people with different drinking preferences, investigating the intake of a large number of food items and nutrients, and linking preference to health outcomes. Next to alcoholic beverage

preference, drinking patterns and absolute alcohol consumption should be analysed and adjusted for⁶⁵. Furthermore, future research should focus on data originating from different countries, not only within Europe but also in other parts of the world. In particular, using standardized exposure and outcome measures across countries would make results comparable.

Implications for studies into the association between alcohol and health outcomes

This review has shown that diet, but also age, gender, and socio-economic status are confounding factors in the association of alcoholic beverage consumption and health outcomes. Confounding is a bias and occurs when the effect of an extraneous factor is mistaken for or mixed with the actual exposure effect (which may be null)³⁷. Therefore, we recommend studies into the association between alcoholic beverages and health outcomes to carefully consider which confounders may be present and use an appropriate statistical method for adjustment to take them adequately into account.

The most reported confounder selection strategy in epidemiological studies is the so-called 'change-in-estimate'. However, this is a data-driven method and does not consider prior knowledge from literature, which is formally seen as the most important rationale for including or excluding covariates⁷¹. In the case of alcohol and health, this review has shown that prior knowledge about confounding factors is present. Therefore, we suggest to choose a confounder selection strategy which takes this into account. Causal diagrams use prior causal knowledge about covariates, including the causal relations between the covariates⁷².

Statistical adjustment for diet as a confounding factor might not be as straight-forward as adjustment for sex or age. Diet comprises a broad range of factors and to avoid loss of precision

one might not want to include too many covariates in a statistical model. One option to adjust for diet is to adjust for the underlying dietary patterns in the study population which can be detected using factor analysis.

Finally, even when all confounding factors are taken adequately into account, residual confounding can still occur due to misclassification and the availability of only one baseline measurement. Therefore, researchers should carefully consider which alcohol exposure they would like to investigate: beverage preference, absolute consumption, or consumption frequency and which implications this could have for their choice of study design and statistical analysis.

Conclusion

This review has shown that the preference for a specific alcoholic beverage is associated with diet. If the type of alcohol consumed is the exposure of interest, diet should be adequately taken into account in the design, analysis and above all the interpretation of the findings. It is likely that the underlying dietary patterns are related to the health outcome rather than the type of alcoholic beverage.

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Table 1. Overview of 16 included studies on the association between alcoholic beverage preference or intake and dietary habits.

Author (year), study, country	Population	Assessment alcohol consumption	Assessment dietary intake	Definition beverage preference	Categories of beverage preference	Outcome	Adjustments
Cross-sectional studies							
Alcácer (2008), the Sun Cohort Study, Spain ⁵¹	10,526 Spanish university graduates recruited 2000-2003; men and women 18-95 y	Self-administered questionnaire, including a 136-item FFQ	Self-administered questionnaire, including a 136-item FFQ	Preference defined as intake of a beverage constituted $\times 50\%$ of total alcohol intake	Wine, beer, spirits, no preference, nondrinkers	<ul style="list-style-type: none"> • Nutrient score • Mediterranean Food Pattern Score 	Food group intake was adjusted for age and energy intake
Barefoot (2002), the UNC Alumni Heart Study, United States ⁵²	4,435 men and women who studied at University of North Carolina in 1964-1966 and their spouses; 99% European American; data used from 1994 questionnaire	153-item FFQ	153-item FFQ	Preference defined as intake of a specific beverage constituted $>50\%$ of total alcohol intake	Wine, beer, spirits, no preference, nondrinkers	<ul style="list-style-type: none"> • Total number of daily servings of fruit, vegetables, red or fried meats • Intake of saturated fat, cholesterol, and fiber 	None. It was tested for sex \times beverage preference interaction
Carmona-	1,675 Spanish	137-item	137-item	Preference	Wine, beer,	<ul style="list-style-type: none"> • Food group 	Age, BMI,

Torre (2008), the PREDIMED study, Spain ⁵³	men aged 55-80 y and 2,150 Spanish women aged 60-80 y at high risk for CVD who were enrolled in a randomized controlled clinical trial on the Mediterranean diet and CVD, recruited 2003-2004 from primary care centers in Spain.	FFQ	FFQ	defined as intake of a specific beverage constituted >50% of total alcohol intake	spirits, no preference, nondrinkers	consumption • Mediterranean Dietary Pattern Score	cholesterol level, and total energy intake
Chatenoud (2000), Italy ⁵⁴	3,261 female and 2,381 male Italian control subjects, 20-74 y (median age 58 y), admitted between 1991 and 1996 for acute non-neoplastic conditions	Structured questionnaire	78-item FFQ	Not known	Wine only, mixed, spirits or beer only, abstainers	Selected indicators of a healthy diet: fruit, raw and cooked vegetables, salad, and fish	Age, study centre, education, BMI, smoking habits

	unrelated to alcohol intake in six Italian areas						
Forshee (2006), Continuing Survey of Food Intake by Individuals 1994-1996, 1998, United States ⁴⁹	6,040 men and 5,858 women representing all non-institutionalized persons >6 years residing in the United States	24h-multi-pass dietary recall instruments administered on 2 nonconsecutive days	24h-multi-pass dietary recall instruments administered on 2 nonconsecutive days	Preference not defined, absolute consumption of alcoholic beverages (wine, beer and ales) was assessed	Wine consumption (g/day), beer and ale consumption (g/day)	Healthy Eating Index	None
Herbeth (2012), STANISLAS study, France ⁶⁴	423 fathers, aged 30-60 y (median 42 y) from a longitudinal study recruited in 1995-95 at the Center for Preventive Medicine in the east of France; of French origin and free of acute of chronic diseases	3-day dietary record, completed on 2 weekdays and 1 weekend day	3-day dietary record, completed on 2 weekdays and 1 weekend day	Preference defined as an intake of pure alcohol $\times 50\%$ of the total alcohol intake	Wine, beer, spirits, no preference	<ul style="list-style-type: none"> Food group intake 2 diet patterns derived from principal component analysis 	Age, non-alcohol energy intake, alcohol intake, cigarette smoking, body mass index, education, and season

Männistö (1997), Finmonica cardiovascular risk factor survey, Finland ⁵⁷	985 women and 863 men; 25-64 y; subsample of 1992 Finmonica risk factor survey; drawn from national population register in four monitoring areas in Finland	<ul style="list-style-type: none"> • Self-administered questionnaire • 3-day food record 	3-day food record	Preference defined when at least 50% of the reported alcohol intake was a specific type	Beer, wine, spirits, mixed, abstainers	Nutrient intake: fat, saturated fat, protein, carbohydrate, sugar, total carotenoids, and vitamin C	Age, area, smoking, education, energy from food and alcohol intake
McCann (2003), United States ⁵⁸	1,846 male and 1,910 female control subjects; 35-79 y; randomly selected 1996-2001 from population of Erie and Niagara Counties; lifetime alcohol abstainers excluded	A detailed computer-assisted interview querying alcoholic beverage intake during the 12 to 24 months prior to interview	Self-administered modified version of the Health Habits and History FFQ developed by the National Cancer Institute	Preference defined when consumption of a specific beverage at least 75% of all drinking occasions constituted	Beer, wine, liquor, mixed, current non-drinkers	<ul style="list-style-type: none"> • Daily intake of macro- and micronutrients • Monthly frequency fruit, juice, vegetable, meat, grain, dairy, dessert intake 	Age, education, smoking status, race, total energy intake, alcohol intake
Paschall (2005), National	12,958 young adults; participants of	Questionnaire on alcohol consumption	Questionnaire	Preference defined by question	Beer, wine, wine cooler/	<ul style="list-style-type: none"> • Fast food consumption • Vegetarian 	Age, sex, race, and marital

Longitudinal Study of Adolescent Health, United States ⁵⁰	National Longitudinal Study of Adolescent Health 1995-2002; randomly selected from 134 middle and high schools in 80 communities in 33 U.S. states	during the prior 12 months		what type of beverage respondent s drank most often	hard cider, liquor/mixed drinks, no preference, ex-drinker, lifetime abstainer		status
Rouillier (2004), the SU.VI.MAX study, France ⁵⁹	2,126 men; from all French regions; 45-60 y; enrolled in 1994 in a randomized controlled trial on efficacy of antioxidant supplementation	24-hour dietary recalls conducted every two months	24-hour dietary recalls conducted every two months	Preference not defined, absolute intake of alcoholic beverages grouped with factor and cluster analysis	Abstainer, low drinker, high quality wine, beer and cider, digestive, local wine, table wine	<ul style="list-style-type: none"> • % Energy intake at breakfast, lunch, dinner, and snacking 	Age
Ruidavets (2004), French MONICA Centres, France ⁶⁰	1,110 middle-aged men, 45-64 y, randomly selected from population of Lille,	Three-consecutive day food intake diary and a quantitative questionnaire	Three-consecutive day food intake diary	Preference was defined when at least 70% of the total alcohol	Beer, mixed, wine	<ul style="list-style-type: none"> • Macronutrient intake • Food group intake • Diet quality index 	Age, schooling, tobacco consumption, physical exercise, BMI,

	Strasbourg, and Toulouse in 1995-1997			was supplied by a specific beverage			dieting, and alcohol consumption
Sánchez-Villegas (2008), the SUN cohort study, Spain ⁶¹	15,073 male and female Spanish university graduates; 18-95 y; recruited 1999-2007	Semi-quantitative 136-item FFQ	Semi-quantitative 136-item FFQ	Preference not defined, absolute intake of specific alcoholic beverages was assessed	Consumption of spirits, total wine, red wine, beer	Major dietary patterns (Mediterranean Dietary Pattern, Western Dietary Pattern) were identified with principal component analysis on 25 pre-defined food groups	Age, gender, energy intake, BMI, leisure-time physical activity, smoking, marital status, and several diseases
Tjønneland (1999), Diet, Cancer and Health Study, Denmark ⁶²	23,284 men and 25,479 women, 50-64 y, randomly selected from the greater Copenhagen and Aarhus area in 1995-1997; of Danish origin, no history of cancer	192-item FFQ	192-item FFQ	Preference was defined when the intake of the preferred beverage constituted $\geq 50\%$ of total alcohol intake	Wine, beer, spirits, mixed, abstainers	Frequency of intake of fish, cooked vegetables, salad, and fruit, categorized as high or low intake, preferred cooking fat, use of fat spread on bread.	Age, level of education, smoking habits, total alcohol, and BMI
Valencia-Martín (2011), Non-	12,037 men and women; 18-64 y;	Structured questionnaire on the	Structured 24-hour recall questionnaire.	The preferred beverage	Beer, wine, spirits, no preference	Adherence to food guidelines of fruits,	Age, sex, educational level, social

communicable Disease Risk Factor Surveillance System, Spain ⁶³	randomly selected from non-institutionalized population in the region of Madrid in 2000-2005	consumption of different alcoholic beverages in the last week		was the drink that accounted for over 80% of the total number of standard units of alcohol consumed.		vegetables, fish, meat, eggs, and milk products and skipping meals.	class, physical activity at work and during leisure-time, tobacco consumption, BMI, alcohol intake, beverage preference, and drinking alcohol with meals
Ecological studies							
Gell (2011), Expenditure and Food Survey 2005-2006, United Kingdom ⁵⁵	3,146 UK households without children; selected from a stratified random sample with clustering from Postcode Address File; at least main shopper of the	Questionnaire and 2-week individual-level diary recording all purchases	Questionnaire and 2-week individual-level diary recording all purchases	A preference for beer, wine or spirits indicated the type of alcohol with the largest household expenditure on- and	Budget spent on wine, beer, and spirits	Expenditure on: <ul style="list-style-type: none"> • healthy food (fruit and vegetables) • unhealthy foods • neutral foods 	None

	household completed 2- week diary in 2005-2006			off-trade alcohol.			
Johansen (2006), Denmark ⁵⁶	3.5 million transactions chosen at random from 98 outlets of two large Danish supermarket chains in 2002-2003	Transactions on beer and wine	Transactions on food	Beer buyers, wine buyers, beer and wine buyers, and non- alcoholic buyers.	Beer buyers, wine buyers, beer and wine buyers, non-alcohol buyers	40 dichotomized categories of food	None

Table 2. Quality assessment of 16 studies into the association between alcoholic beverage preference and diet.

Study	External validity	Internal validity						Total
	Representative ^a	Alcohol assessment ^b	Definition alcoholic beverage preference ^c	Dietary assessment ^d	Attrition ^e	Statistical analysis ^f	Adjustment ^g	
Alcácer ⁵¹	-	*	*	*	*	*	**	7/8
Barefoot ⁵²	-	*	*	*	*	*	-	5/8
Carmona-Torre ⁵³	-	*	*	*	*	*	**	7/8
Chatenoud ⁵⁴	-	*	not known	*	*	*	**	6/8
Forshee ⁴⁹	*	*	not known	*	not known	-	-	3/8
Gell ⁵⁵	-	*	*	*	*	*	-	5/8
Herbeth ⁶⁴	-	*	*	*	-	*	**	6/8
Johansen ⁵⁶	*	-	*	-	*	*	-	4/8
Männistö ¹⁰	*	*	*	*	*	*	**	8/8
McCann ⁵⁸	-	*	*	*	*	*	**	7/8
Paschall ⁵⁰	*	-	*	-	*	*	*	5/8
Rouillier ⁵⁹	-	*	*	*	*	*	*	6/8
Ruidavets ⁶⁰	*	*	*	*	*	*	**	8/8
Sánchez-Villegas ⁶¹	-	*	*	*	not known	*	**	6/8
Tjønneland ⁶²	*	*	*	*	*	*	**	8/8
Valencia-Martín ⁶³	*	*	*	*	*	*	**	8/8

^a Representative: Study receives a * if the study sample includes all eligible persons over a defined period of time or in a defined catchment area, or a random or systematic sample of those persons.

^b Assessment method of alcohol consumption: Study receives a * if alcohol consumption was assessed with a standardized

questionnaire or interview.

^c Definition of alcoholic beverage preference: Study receives a * if the definition of alcoholic beverage preference is adequately described.

^d Dietary assessment method: Study receives a * if diet is assessed with a well-established method, including food frequency questionnaire, 24-hour recall or dietary record.

^e Attrition: Study receives a * if the analyses are performed on the complete or nearly complete data.

^f Statistical analysis: Study receives a * if the performed statistical analyses were adequately described and appropriate for the study question.

^g Confounder adjustment: If adjustment was performed for the following variables, the study receives a * when adjusted for age and sex (if not stratified) and a * when adjusted for further variables, such as SES or education, lifestyle factors (energy intake, BMI, physical activity, smoking), and alcohol consumption.

Table 3. Summary of results from 16 included studies according to beverage preference.

Result		Alcoholic beverage preference				Non-consumer
		<i>Beer</i>	<i>Wine</i>	<i>Spirits</i>	<i>No preference / mixed</i>	
Mediterranean populations						
Alcácer (2008), Spain ⁵¹	Preference	25%	29%	16%	8%	21%
	Dietary intakes	No significant differences	Energy - Energy from lipids - Alcohol + Fiber + Dairy ó Fruits ó Legumes ó Fast food - Sugared soda drinks ó Meat ó Olive oil +	Energy + Energy from lipids +	Energy - Alcohol + Energy from lipids +	Energy - Carbohydrate + Fiber +
Carmona-Torre (2007), Spain ⁵³	Preference	10%	45%	3%	5%	37%
	Dietary intakes	No significant differences	Fruit ó Meat products ó Fast foods -	No significant differences	No significant differences	No significant differences
Chatenoud (2000), Italy ⁵⁴	Preference	Combined with spirits: 2% and 3%	43% and 38%	Not defined	12% and 48%	42% and 10%
	Dietary intakes	No significant differences	No significant differences	No significant differences	No significant differences	No significant differences

Herbeth (2012), France ⁶⁴	Preference	Not known	Not known	Not known	Not known	Not known
	Dietary intakes	No significant differences	No significant differences	Poultry +	No significant differences	No significant differences
Rouillier (2004), France ⁵⁹	Preference	9% (beer and cider cluster)	42% (high quality wines, local wines, table wines clusters)	3% (digestives cluster)	32% (low drinkers cluster)	15%
	Dietary intake	En% snacking +	Table wine cluster: En% breakfast + En% lunch + High quality wine cluster: En% dinner +	No significant differences	No significant differences	En% snacking + En% dinner -
Ruidavets (2004), France ⁶⁰	Preference	10%	62%	Not defined	28%	Not defined
	Dietary intakes	Energy + Fat + En% protein - Carbohydrates + High-fat meat + Potatoes +	Energy - En% Fat - En% protein + Dietary cholesterol + Fiber + Fish + Vegetables + Fruit + Bread + Soft cheese + Dairy + Eggs + Diet quality index +	-	En% fat +	-
Sánchez-	Preference	Not known	Not known	Not known	Not	Not defined

Villegas (2008), Spain ⁶¹	e				defined	
	Dietary intakes	Western pattern - Mediterranean pattern -	Western pattern - Mediterranean pattern +	Mediterranean pattern -	-	-
Valencia-Martín (2011), Spain ⁶³	Preference	15%	13%	7%	65%	24%
	Dietary intakes	Guidelines on: Fruit and vegetables ó Meat ó Fish ó Eggs ó	No significant differences	Guidelines on: Fruit and vegetables ó Skipping breakfast +	No significant differences	No significant differences
Western populations						
Barefoot (2002), U.S. ⁵²	Preference	14% and 36%	46% and 23%	12% and 14%	4% and 9%	23% and 17%
	Dietary intakes	No significant differences	Fruit + Vegetables + Red or fried meats - Dietary fiber + Saturated fat ó Cholesterol ó Alcohol -	Red or fried meats + Cholesterol + Alcohol +	Alcohol +	Fiber + Vegetables -
Forshee (2006), U.S. ⁴⁹	Preference	Not known	Not known	Not defined	Not defined	Not defined
	Dietary intakes	Healthy Eating Index - Healthy Eating Index +	Healthy Eating Index +	-	-	-

Gell (2011), U.K. ⁵⁵	Preference	Not known	Not known	Not known	Not defined	Not defined
	Dietary intakes	Budget on healthy foods ó Budget on unhealthy foods -	Budget on healthy foods + Budget on unhealthy foods -	Budget on healthy foods ó Budget on unhealthy food +	-	-
Johansen (2006), Denmark ⁵⁶	Preference	6.6%	5.8%	Not defined	1.2% bought both beer and wine	Not defined
	Dietary intakes	Chips + Soft drinks + Lamb + Sausages + Bread ó Cereals ó Sweets - Butter or margarine + Pork + Cold cuts + Sugar + Ready cooked dishes + Olives ó Fruit ó Vegetables ó Cooking oil ó Poultry ó Low-fat milk ó Low-fat cheese ó Low-fat meat ó	Oil + Olives + Veal + Beef +	-	No. of food items + Budget spent +	-
Männistö (1997), Finland ⁵⁷	Preference	43% and 25%	9% and 26%	26% and 16%	14% and 15%	8% and 18%

	Dietary intakes	Carotenoids -	Carotenoids +	No significant differences	No significant differences	En% carbohydrate + En% fat + En% protein - Vitamin C -
McCann (2003), U.S. ⁵⁸	Preference	20% (31%, 9%)	16% (10%, 21%)	10% (11%, 9%)	23% (21%, 24%)	32% (27%, 37%)
	Dietary intakes	Fruits and juices - Vegetables + MUFA +	Carbohydrates + Protein + Dietary fiber + Potassium + Folate + Vitamin C + Carotenoids + Fruits and juices + Vegetables + Grains + Meat -	Total fat + Meat + Meat - Dairy + Grains -	Fruits and juices +	En% Carbohydrates + En% Fat + En% protein + Cholesterol + Dietary fiber + Potassium + Carotenoids + MUFA + Fruits and juices + Vegetables + Vegetables - Desserts + Grains + Dairy -
Paschall (2004), U.S. ⁵⁰	Preference	34%	12% (5% wine, 7% wine cooler / hard cider)	26% (incl. mixed drinks)	3%	26% (12% ex-drinkers, 14% lifetime abstainers)
	Dietary intakes	No significant differences	No significant differences	No significant differences	No significant differences	Fast food + (esp. ex-drinkers)

					s	
Tjønneland (1999), Denmark ⁶ ₂	Preference	11% and 38%	54% and 30%	4% and 3%	22% and 26%	10% and 3%
	Dietary intakes	Fruits ó Fats on bread +	Fruit + Vegetables + Fish + Salads + Olive oil + Fats on bread -	No significant differences	No significant difference s	Fruit + Fish ó Vegetables ó Salad -

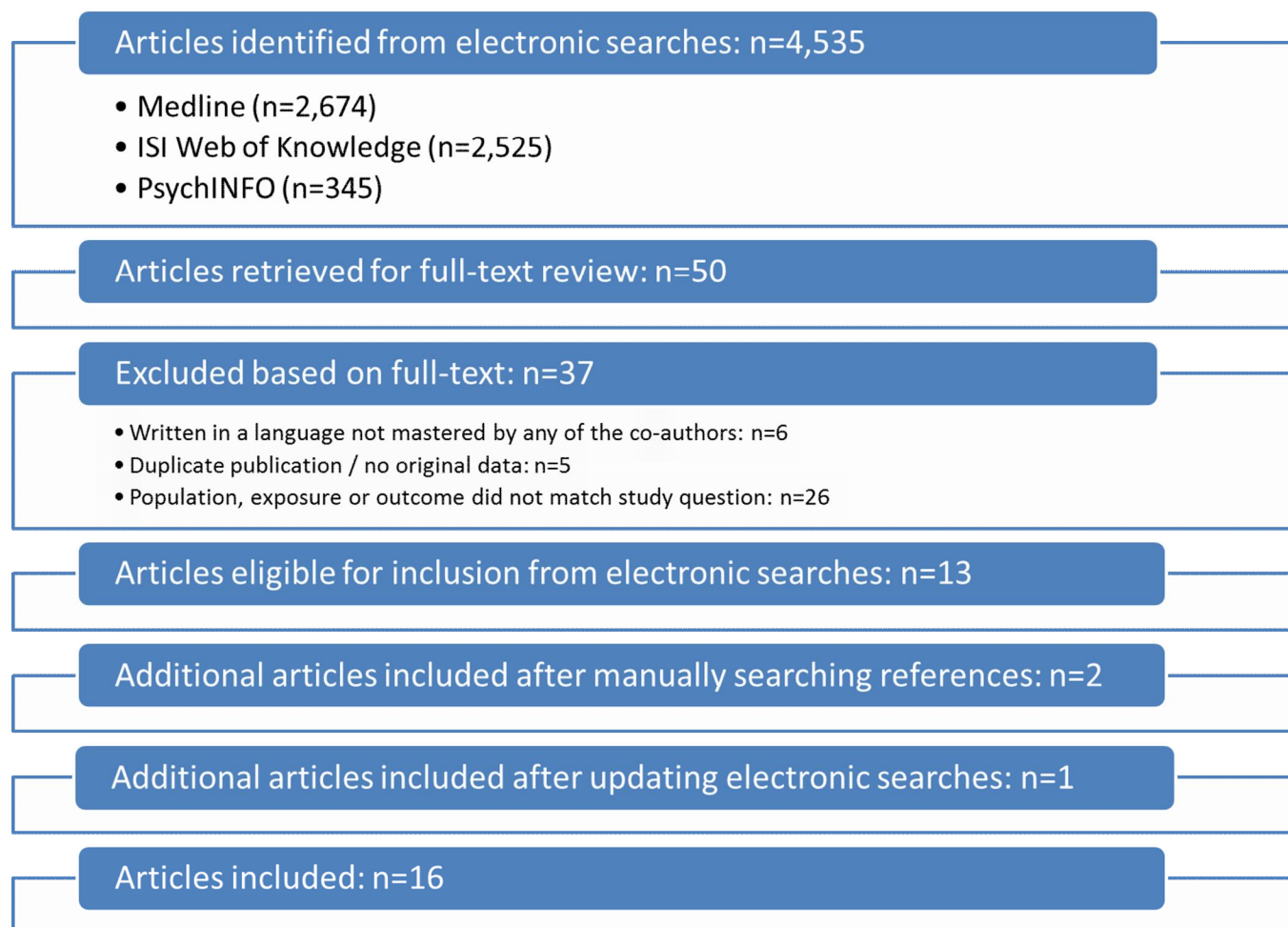


Figure 1. Flow-chart of the systematic literature search for studies into the association between alcoholic beverage preference and diet, published up to March 2013.