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Alcohol, cardiovascular disease and industry funding: A co-authorship network analysis of epidemiological studies

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ABSTRACT

Introduction: Alcohol's effects on cardiovascular disease (CVD) are controversial. Alcohol industry actors have shown particular interest in this subject, and been extensively involved through research funding, and in other ways, generating concerns about bias, particularly in reviews.

Material & methods: We conducted a co-authorship network analysis of the primary studies included within a previous co-authorship study of 60 systematic reviews on the impact of alcohol on CVD. Additionally, we examined the relationships between declared alcohol industry funding and network structure.

Results: There were 713 unique primary studies with 2832 authors published between 1969 and 2019 located within 229 co-authorship subnetworks. There was industry funding across subnetworks and approximately 8% of all papers declared industry funding. The largest subnetwork dominated, comprising 43% of all authors, with sparse evidence of substantial industry funding. The second largest subnetwork contained approximately 4% of all authors, with largely different industry funders involved. Harvard affiliated authors who at the review level formed co-authorship subnetworks with industry funded authors were seen at the primary study level to belong to the largest epidemiological subnetwork. A small number of key authors make extensive alcohol industry funding declarations.

Conclusions: There was no straightforward relationship between co-authorship network formation and alcohol industry funding of epidemiological studies on alcohol and CVD. More fine-grained attention to patterns of alcohol industry funding and to key nodes may shed further light on how far industry funding may be responsible for conflicting findings on alcohol and CVD.

1. Introduction

Alcohol is a major cause of the global burden of disease, with risk increasing with level of consumption (Griswold et al., 2018). This problem is expected to worsen without action to reverse forecast trends, particularly in low and middle-income countries where the alcohol market is expanding (Manthey et al., 2019). Against this backdrop, there has been a major scientific controversy for some decades about whether small amounts of alcohol may be cardioprotective, as complete abstainers appear to have worse health than low level drinkers (Oppenheimer and Bayer, 2020). This group, however, may have worse health outcomes because of prior heavy drinking causing health problems that led to abstinence, known as the 'sick quitter' hypothesis (Stockwell et al., 2016). There is substantial unexplained heterogeneity measured in meta-analytic studies (Roerecke and Rehm, 2012; Golder and McCambridge, 2021) and exposure to alcohol is challenging to accurately measure due to recall and social desirability biases (Naimi et al., 2013). The putative cardiovascular disease (CVD) effects belong to a wider set of claimed health benefits of alcohol, a number of which have no plausible biological mechanisms (Fekjaer, 2013).

It is known that industry actors across sectors fund research to influence research agendas (Fabbri et al., 2018). It is now well established that large corporations sponsor and shape science deliberately to distract from the damage caused by their activities across different sectors (Oreskes and Conway, 2010; McGarity and Bending, 2012; Popp et al., 2018; Bes-Rastrollo et al., 2013; Mandrioli et al., 2016; Dunn et al., 2014; Hansen et al., 2019; Newman, 2004). These include the tobacco industry, (Barnes and Bero, 1996) the food industry, (Fabbri et al., 2018) and the pharmaceutical industry (Lundh et al., 2017).

The alcohol industry has sponsored studies in the alcohol and CVD literature (Golder and McCambridge, 2021; McCambridge and Hartwell, 2015; McCambridge, 2018). Key industry actors have used evidence of

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purported health benefits in largely successful efforts to influence public policy globally, in particular by suggesting that alcohol is different from tobacco because of claimed health benefits (McCambridge et al., 2018; Savell et al., 2016). A review undertaken by the alcohol industry itself found no associations between alcohol industry funding and a range of health outcomes, including CVD, in meta-analytic studies (Vos et al., 2020). Major alcohol companies also funded the only clinical trial on whether low dose alcohol confers CVD benefits, which was stopped soon after the trial began because it was found to be biased (Mitchell et al., 2020).

Evidence is accumulating that the alcohol industry has not only behaved like the tobacco industry in perpetrating a decades-long conspiracy to subvert the peer-reviewed science base, but that they have in fact shared origins (McCambridge et al., 2021). It is well known that Hill and Knowlton, a public relations company, developed and managed the tobacco industry's scientific programmes from the early 1950s onwards (Proctor, 2012; Brandt, 2007). A recent internal documents study has identified that Hill and Knowlton had worked previously with the key distilled spirits trade association in the U.S. (McCambridge et al., 2021). At the heart of the approach for both tobacco and alcohol was funding research to advance what were explicitly conceived as public relations goals (McCambridge et al., 2021).

Collaborations in research are increasingly encouraged by a wide range of influences within science (Koseoglu, 2016; Carpenter et al., 2014). Co-authorship network analysis (Fonseca et al., 2016) is one method that can be used to study relationships between authors, capable of examining relationship structure, formation of groups or cliques, and identifying influencers. A high density network may indicate enhanced cohesiveness within a research field and a greater willingness to engage in collaboration between authors. There is a range of centrality measures available to identify key authors and their roles within networks.

The impetus for this study came from the findings of a previous study in which we studied co-authorship patterns (networks) in 60 systematic reviews on the impacts of alcohol on cardiovascular disease (CVD) (Golder and McCambridge, 2021). That study found collaborations varied in extent of industry funding, and reviews undertaken by authors with any histories of industry funding were distinct in study designs (Golder and McCambridge, 2021). The findings of reviews undertaken by authors with industry funding histories exclusively identified cardioprotective effects of low alcohol consumption, whereas other reviews produced mixed findings, and industry linked authors tended not to collaborate with authors with no industry funding history. Review authors may or may not be authors of studies included in reviews. Also biases in this literature may operate at the primary study level, the review level or both. Indeed as reviews are important to policy, it may be that any industry influence is more pronounced in reviews.

There is thus a major unresolved scientific controversy about alcohol and CVD. Our previous study showed that industry funding is implicated in this situation, and there has been little prior study of how this may influence findings. This is challenging to study. In the present study, our aims were to further examine co-authorship patterns in this literature, and to investigate in more depth relationships with industry. This will help both develop methods and shed light on whether the underlying epidemiological literature exhibits similar patterns to the findings on industry funding and reviews.

2. Material and methods

Systematic reviews, and the primary studies included within them, are important to decision-making. We carried out a co-authorship network analysis using the included studies from the 60 systematic reviews in our previous study in a series of steps. Firstly, we created an Endnote library of the studies that met the inclusion criteria within each of the systematic reviews of the impacts of alcohol on CVD (Golder and McCambridge, 2021). We added any declared alcohol industry funding of the studies themselves from examination of the full texts. Secondly, we prepared the data for network analysis by cleaning the author field by checking for inconsistencies, typographical errors, and checking affiliations to ensure that each author was a distinct individual. Thirdly, we carried out the network analysis which included a visualisation of the network of authors, and generated metrics which help identify the key authors in the networks, and in the literature as a whole.

In order to construct and visualise the co-authorship network we used the open source software Gephi: https://gephi.org/. Each unique author is represented by a circular shape, the size of the circle depicts the number of papers published by that author. Any line connecting a pair of authors represents co-authorship, and the thickness of the line is weighted by the number of publications co-authored by that pair of authors. The network graph allowed us to visualise groups of authors connected directly (co-authorship on the same paper) and indirectly (connected through a mutual co-author on separate papers).

To understand how this literature has accumulated over time, we explored changes in the co-authorship network structure, calculating key metrics in 1980, 1990, 2000, 2005, 2010, 2015 and 2019 (the year the last primary study was published). The size of the overall network was measured using the number of authors and number of co-authorships. The density of the network was calculated by dividing the number of co-authorships that exist with the maximum possible number of co-authorships that can exist. The higher the density, therefore, the closer authors are connected to each other.

To identify key researchers in this literature the following metrics were used: (1) productivity of the authors in the form of the highest number of included primary studies authored; (2) betweenness centrality, which means the prominence of the author's position in the network (i.e. how much an author connects other authors via the shortest path possible i.e. acting as "bridges" between authors; (3) degree centrality, the number of co-authorships; and (4) and closeness centrality, how closely an author is connected to all other authors in the network i.e. measuring the average shortest path to each other author in the network (Fonseca et al., 2016).

Finally, for each key researcher we conducted a search of the Organization-Enhanced [Index], Organization, Suborganization, Funding Agency, and Funding Text fields for known alcohol companies and related organisations in the Web of Science suite of databases (Golder et al., 2020). Although we did not impose any date restrictions the funding sections of journal article acknowledgements, declarations of interest have only been processed in Web of Science since August 2008. We also checked for known industry funding histories listed in our previous paper (Golder and McCambridge, 2021).

3. Results

3.1. Characteristics of the included studies

There were 713 unique primary studies with 2832 unique authors published between 1969 and 2019. The observed reduction over the past 10 years is an artefact of using reviews to identify the primary literature, as more recent studies are less likely to have been included. Only five studies were not published in English. Of the 713 included studies we could not locate three of the full-text papers. Fifty five of the 710 (approximately 8%) had some form of alcohol industry funding for the study declared within the full-text.

Only 5% (11/207) of studies published from 2008 onwards, when Web of Science began routinely collecting sources of funding and conflicts of interest data, declared alcohol industry funding in the full-text. This indicates that studies with declared industry funding are less common over the past 15 years. The proportion of studies with declared industry funding peaked in the late 1980s, with 27% of all papers published in 1988 and 1990 (Fig. 1). The actual number of publications with declared industry funding, however, peaked much later in 2007, as the trend over time was for more papers to be published (Fig. 1).

The 713 unique papers were published in 197 different journal titles

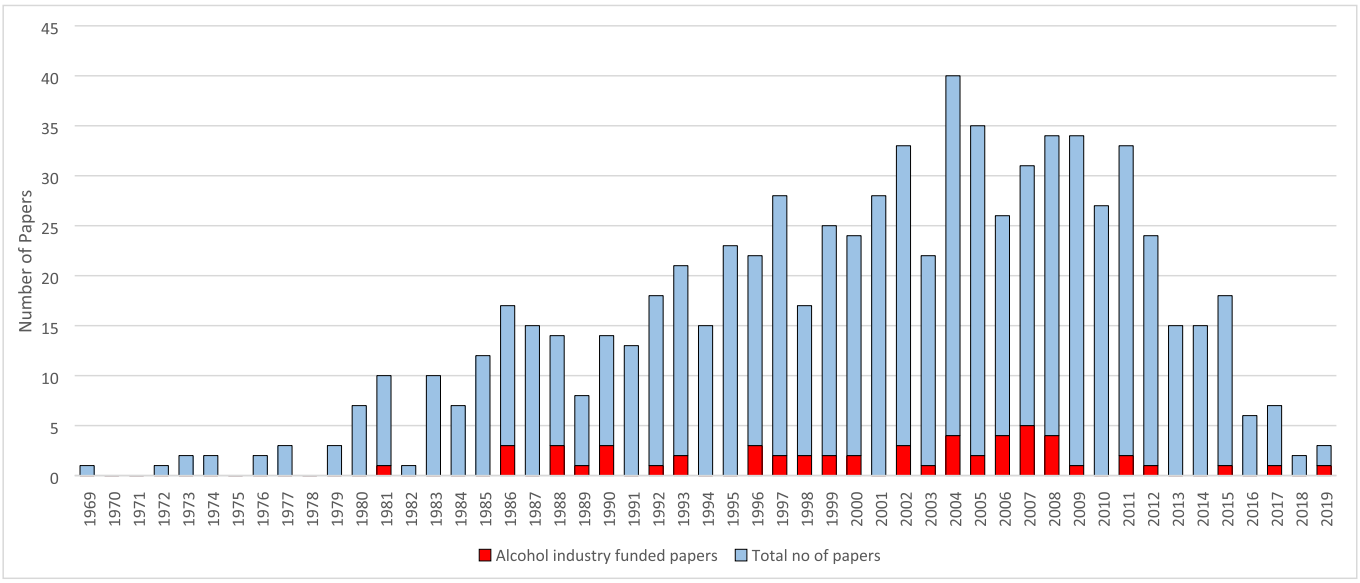


Fig. 1. Year of publication of 713 included studies and declared alcohol industry funding.

and in one book. The journal titles were categorised by the authors as 'cardiology', 'general medical journals' 'epidemiology', 'alcohol or addiction' or 'other'. Over a third (246 (35%)) of the papers were published in cardiology journals (such as 'American Journal of Cardiology', 'Circulation' or 'Stroke') and over one fifth (154/713, 22%) in general medical journals (such as the 'Archives of Internal Medicine', 'BMJ' or 'Lancet'). Less commonly, approximately 14% (97/713) were published in epidemiology journals and approximately 10% (73/713) were published in alcohol or addiction journals. The most common journals in which the studies were published were 'Stroke' (45/713, 6.3%) followed by 'Circulation' (31/713, 4.3%), 'American Journal of Epidemiology' (29/713, 4.1%), 'BMJ' (24/713, 3.4%) and 'International Journal of Epidemiology' (22/713, 3.1%).

3.2. Subnetworks within the overall network

The 2832 authors formed 13,478 co-authorships in 229 subnetworks (Fig. 2). The largest network (subnetwork 4: Purple) contained 43% (1223/2832) of all authors. Within this one subnetwork most of the authors (68%, 835/1223) had only authored one paper, and although the U.S. is the most common home, this subnetwork is international in nature.

The second largest (subnetwork 16: Green) was much smaller, consisting of only 121 authors (4%, 121/2832) in 14 publications between 1993 and 2018 and with a high proportion (84%, 102/121) of the authors having only authored one paper in the network.

The overall network is also heavily dominated by authors having only authored one paper (78%, 2202/2832) in the network, with 91% (2584/2832) of all authors having authored two or fewer papers.

3.3. The development of co-authorship networks over time

Table 1 summarises characteristics of the authorship network over time. The overall network reduced in density up to 2010 as the number of subnetworks increased. The diameter of the network (the shortest distance between the two most distant nodes) increased to 2005. As expected the average number of studies per author increased slightly over the time. When authors with only one paper published in the network are excluded, the average number of papers per author can be seen to increase more clearly from 2.07 to 3.16. The average number of co-authorships per author in the network (average degree) also increased, as authors published increasingly with greater numbers of co-authors. The proportions of isolates was consistent over time at approximately 78%. The increasing prominence and connectivity of subnetwork 4 is apparent after 2000.

3.4. Most influential authors

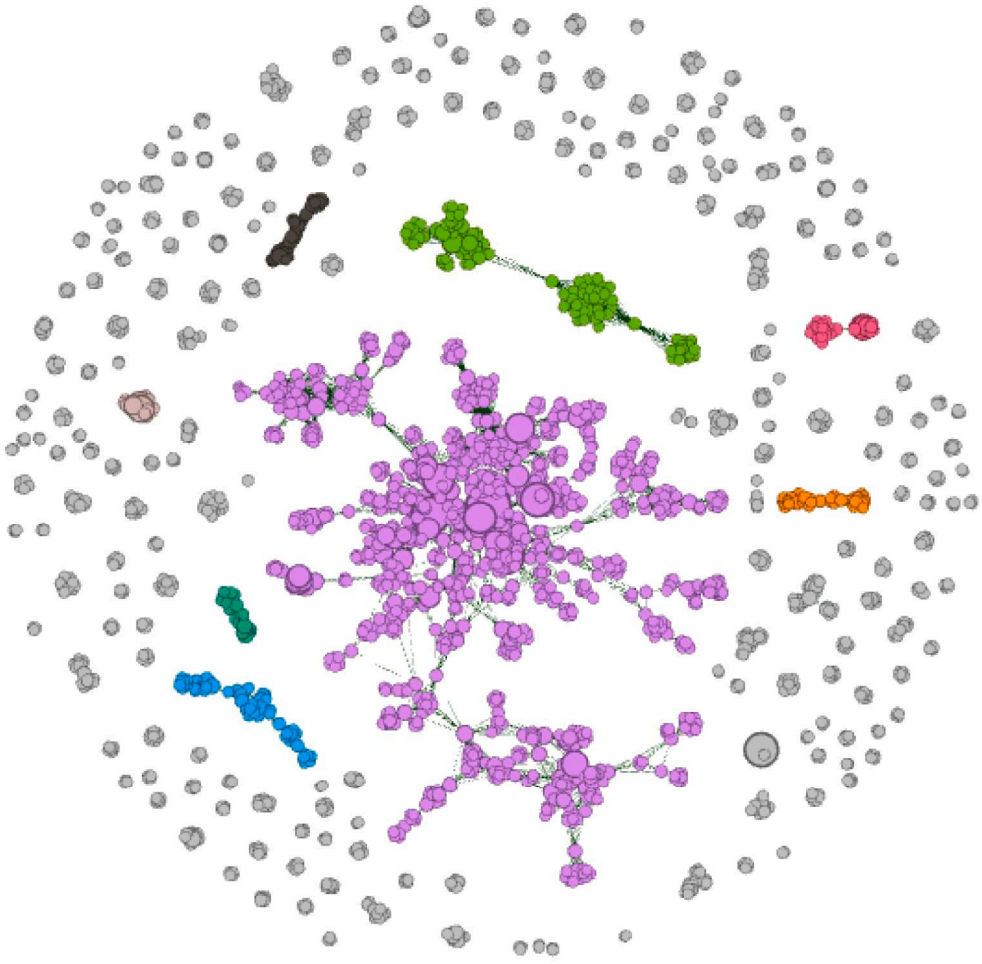
The most influential authors within the authorship network (i.e. on publications) were identified using a variety of measures (Table 2 presents data on those with more than 10 papers). Those with the highest number of publications within the 713 papers were Stampfer, Mukamal and Gaziano (all from subnetwork 4). Those who collaborated with the highest number of authors (degree centrality) were also all from subnetwork 4 (Stampfer, Mukamal and Beulens). The key authors most commonly connecting other co-authors (betweenness centrality) were Mukamal, Ueshima and Kuller. Harvard is clearly important not only within subnetwork 4 but in this research field more broadly (Table 2). The findings for closeness centrality are rather different, with 953 authors scoring one (meaning that the author is directly connected to all other authors in the network). Among the most common authors in Table 2 only Klatsky scores one (in subnetwork 9). Over half (58%, 11/19) of the most influential authors in Table 2 have at some point in their careers declared alcohol industry funding, often from a single source.

The most influential author in subnetwork 16 is Estruch, according to all metrics used (Table 3). This subnetwork is led from Spain, but does include co-authors from other countries, most notably Italy and the U.S. The industry funders involved with this subnetwork are almost entirely distinct, with few funders overlapping with the most common authors in subnetwork 4.

3.5. Patterns of alcohol industry funding

It should be borne in mind that norms around declarations of industry funding are changing, and indeed have improved over time (Moynihan et al., 2019), but remain low when undisclosed conflict of interests can be determined (Grundy et al., 2018; Moynihan et al., 2019). Declared industry funding, should very much be regarded as identifying the tip of the iceberg (Golder et al., 2020). This complicates considerably appreciation of trends over time and the sparse data available places limits on the quantitative study of the patterns of alcohol industry funding that is now possible.

The most common sources of funding are not the companies themselves but organisations created and funded by alcohol companies.



Largest network (Subnetwork 4 in the text) containing 43.19% of authors including Stampfer, Mukamal and Gaziano

Second largest network (Subnetwork 16 in the text) containing 4.27% of authors including Estruch

Third largest network containing 2.15% of authors

Fourth largest network containing 1.2% of authors

Fifth largest network containing 1.17% of authors

Sixth largest network containing 1.02% of authors

Seventh largest network containing 0.92% of authors

Eighth largest network containing 0.85% of authors

Subnetworks smaller than 0.85% are in grey

Fig. 2. Co-authorship network analysis Largest network (Subnetwork 4 in the text) containing 43.19% of authors including Stampfer, Mukamal and Gaziano Second largest network (Subnetwork 16 in the text) containing 4.27% of authors including Estruch Third largest network containing 2.15% of authors Fourth largest network containing 1.2% of authors Fifth largest network containing 1.17% of authors Sixth largest network containing 1.02% of authors Seventh largest network containing 0.92% of authors Eighth largest network containing 0.85% of authors Subnetworks smaller than 0.85% are in grey.

Table 1
Cumulative structural and network metrics over time.

Year	1980	1990	2000	2005	2010	2015*	2019*
Total studies	21	118	310	458	596	697	713
Total authors	66	369	1049	1633	2193	2716	2832
Average studies/author	1.24	1.37	1.42	1.46	1.47	1.48	1.46
Average studies/author with more than one paper	2.07	2.67	2.98	3.08	3.12	3.16	3.14
Average authors/study	3.9 (82/21)	4.3 (506/118)	4.8 (1488/310)	5.2 (2381/458)	5.4 3217/596	5.7 (4007/697)	5.8 (4153/713)
Co-authorships	161	947	3189	5604	8232	12,051	13,478
Network density[1]	0.075	0.014	0.006	0.004	0.003	0.003	0.003
Network diameter[2]	2	4	8	16	16	15	15
Average degree centrality[3]	4.879	5.1333	6.08	6.863	7.508	8.874	9.518
Average weighted degree[4]	5.727	6.168	7.192	8.034	8.75	10.219	11.017
Number of subnetworks	16	68	144	172	210	226	229
Largest subnetwork	18.18 %	7.32 %	11.73 %	20.76 %	36.3 %	43.3 %	43.19 %
Second largest network	18.18 %	4.07 %	3.24 %	6.98 %	2.1 %	2.32 %	4.27 %
Most common author	A Berg with 3 papers	A.L Klatsky and T Gordon with 7 papers each	C. H. Hennekens with 17 papers	M.J. Stampfer with 18 papers	M.J. Stampfer with 21 papers	M.J. Stampfer with 23 papers	M.J. Stampfer with 25 papers

* the numbers within the most recent years do not represent the totality of studies published in these years in this area because of the time lag to inclusion in systematic reviews. [1]Network density is calculated by dividing the number of co-authorships that exist with the maximum possible number of co-authorships that can exist. [2]Network diameter is the shortest distance between the two most distant authors. [3]Average degree centrality is the average number of co-authorships. [4]Average weighted degree is average number of papers co-authored with each co-author.

These include the now closed Alcoholic Beverage Medical Research Foundation (ABMRF) and the European Research Advisory Board (ERAB, sometimes known as the European Foundation for Alcohol Research), both of which were created specifically to provide funding to researchers. Other notable funders are the Dutch Foundation for Alcohol Research, the Australian Brewers' Foundation, The Foundation for Wine and Nutrition Research (FIVIN); Cerveceros de Espana, Assobirra, the Italian Association of the Beer and Malt Industries, and the Beer and Health Foundation.

Industry funding within the subnetworks appears largely channelled through nodes in different ways. Some authors have largely been funded by a single industry source, whereas a small number of others have been funded via multiple industry sources. Among these are individuals such as Hendriks, Estruch and Lamuela-Raventos who have reported also performing other roles for industry organisations (Golder and McCambridge, 2021). Time patterns are difficult to ascertain as dates are not usually given, and awarded funding can support publications many years later. There are a small number of authors who appears to have funding relationships that extend over many years, and a larger number who report having had one or two industry grants, who later do not report having any further such awards.

4. Discussion

Industry funding of research on alcohol and CVD is longstanding and continuing. Among 713 studies published between 1969 and 2019, approximately 8 % of all papers made declarations of industry funding. One co-authorship subnetwork comprised 43 % of all authors, with modest evidence of substantial long running declared industry funding among the influential authors (see Table 2; data not reported on the duration of funding). The second largest subnetwork contained approximately 4 % of all authors, with similar evidence on the extent of industry involvement, though involving a different set of alcohol industry funders (see Table 3; data not reported on the duration of funding). Whilst the proportion of studies with declared alcohol industry funding is low, industry funding may exert effects in subtle ways, and be amplified by network participation. There is industry funding across the subnetworks. A small number of key authors have reported multiple sources of alcohol industry funding.

The studies included here were selected via their inclusion in 60 systematic reviews on alcohol and CVD published up to 2019. These investigated any adult population with alcohol as an exposure, a comparator of no or lower alcohol intake, and any CVD primary outcome. It is possible that there may have been important evidence in more recent studies or outside these criteria which has a bearing on study findings. For example, Estruch and Hendriks (Estruch and Hendriks, 2022) in subnetworks 16 and 4 respectively have recently published a systematic review together, with no other co-authors, that was funded by Diageo, a major spirits producer. That review found that moderate consumption of beer, wine and spirits are equivalent in relation to health outcomes, a finding that will not have displeased the sponsor, if there are heightened concerns about distilled spirits in particular, bearing in mind the ingestion of more potent forms of drugs generally does more harm than less potent ones.

Data on industry funding is known to be incomplete and subject to a range of biases that are challenging to estimate reliably. We cannot make any claim to have identified all industry funding that has been declared by these authors in studies not included among the 713 examined here, as that would require examination of all full text papers produced throughout their careers. For example, we identified no declarations from Rubin who co-authored two papers in subnetwork 16. This author has proposed that doctors recommend alcohol consumption for cardioprotection reasons (Rubin, 2014) without disclosing the performance of ABMRF roles for more than 20 years until the time of publication of this proposal (Naimi et al., 2015). Presumably having acted as an expert witness for the tobacco industry was also not deemed relevant by this author (Schick and Glantz, 2007). Even when declarations are conscientiously made, there are obvious limitations to those that are restricted to relatively short timeframes, such as three years. Also, they do not necessarily give accurate information on the role of the sponsor in the research (Rasmussen et al., 2018; Bero et al., 2005). Our validity checks with the full-text papers have established that since 2008 Web of Science captures the declarations made by the authors for this set reliably.

The 43% of authors who belonged to the largest subnetwork in this study is lower than in other studies: 73% for a psoriasis research network (González-Alcaide et al., 2015); 70% for HIP and HPV (Vanni et al., 2014); 80% for leishmaniasis (González-Alcaide et al., 2013); 84% for Chagas (González-Alcaide et al., 2012); and 95% for coronary heart disease (Yu et al., 2013). This points towards authorship practices in the alcohol and CVD research community that are not present in other scientific communities. The existence of high proportions of isolates who may be transient authors is similar to what has been observed in other scientific disciplines, and may be linked to student activity in research or

Table 2
Authors with more than 10 papers in the whole network.

Author	No of papers	Subnetwork number	Country Based	Years	Closeness centrality	Degree centrality	Betweenness centrality	Harvard affiliated yes/ no (years)	If industry funding declared names of funders
Stampfer, Meir J.	25	4	USA	1988–2018	0.256669	93	57,984	Yes (1982–2021)	ILSI Europe Alcohol Task Force*
Mukamal, Kenneth J.	20	4	USA	2001–2016	0.283264	69	215,240	Yes (1999–2021)	Anheuser-Busch InBev, Carlsberg Breweries A/S, Diageo plc, Heineken, Pernod Ricard USA LLC
Gaziano, J. Michael	20	4	USA	1997–2014	0.253002	52	54,936	Yes (1993–2021)	None identified
Hennekens, Charles H.	17	4	USA	1979–200	0.239984	55	97,739	Yes (1979–2017)	None identified
Hendriks Henk F.J.	17	4	Netherlands	1994–2012	0.247368	40	32,129	No	Dutch Foundation for Alcohol Research (SAR), ERAB, ILSI Europe Alcohol Task Force
Klatsky, Arthur L.	17	9	USA	1974–2015	1	13	29	No	ILSI Europe Alcohol Task Force, ABMRF, Wine Institute of San Francisco, US Brewers' Association
Rimm, Eric B.	16	4	USA, Canada	1991–2012	0.273623	49	104,811	Yes (1990–2021)	ILSI Europe Alcohol Task Force
Willett, Walter C.	16	4	USA	1979–2012	0.263249	60	67,657	Yes (1979–2021)	ABMRF
Gronbaek, Morten	16	4	Denmark	1994–2013	0.266115	56	49,331	No	ERAB
Rehm, Jurgen	14	4	Canada, Germany, Switzerland	1993–2014	0.219824	53	46,500	No	None identified
Manson, JoAnn E.	13	4	USA	1995–2012	0.258133	39	33,872	Yes (1993–2021)	None identified
Buring, Julie E	13	4	USA	1997–2012	0.218526	33	5705	Yes (1988–2021)	None identified
Iso, Hiroyasu	12	4	Japan	1995–2014	0.152255	60	49,165	Yes (2017–2017)	None Identified
Puddey Ian. B	12	11	Australia	1985–2016	0.92	17	4783	No	Australian Brewers' Foundation
Beilin, Lawrence J.	12	11	Australia	1985–2016	0.92	21	78	No	Australian Brewers' Foundation
Hillbom, Matti	12	4	Finland	1985–2001	0.148031	21	78	No	None Identified
Friedman, G. D.	12	9	USA	1974–2006	0.928571	12	19.5	No	US Brewers' Association, ABRMF, Wine Institute of San Francisco
Shaper, A. G.	11	41	UK	1987–2015	0.622222	11	143	No	None identified
Armstrong, M.A.	11	9	USA	1986–2003	0.619048	5	1.8	No	ABMRF, Wine Institute of San Francisco

*ILSI Europe Alcohol Task Force. Alcohol industry members of this task force were the companies Allied Domecq, Brasseries Kronenbourg, Diageo, Heineken and Moët et Chandon

NB Some influential authors had less than 10 papers. Beulens JWJ, 9 papers, degree centrality 65, Ueshima, H. 5 papers, betweenness centrality 193,086 and Kuller, L. H., 8 papers, betweenness centrality 165,685.

other factors. The proportion of authors with a single publication in this network (78 %) is similar to networks in regenerative periodontal surgery (80%) (Gutiérrez-Vela et al., 2012) and telepathology (76%) (Della, 2011), although higher than in psoriasis in which 69% of authors published a single work (González-Alcaide et al., 2015). The proportion of authors who have published 10 or more papers in our network (2.66%) is close to that reported for the psoriasis research network with 2.85% (González-Alcaide et al., 2015), though is higher than in a previous study of the alcohol research field more broadly (1.45%) (González-Alcaide et al., 2013).

Harvard affiliated authors who at the review level formed co-authorship subnetworks with industry funded authors are seen at the primary study level examined here to belong to the largest epidemiological subnetwork, and indeed are highly influential within it. While many of the most influential authors in the field have at least some history of alcohol industry funding, this is largely modest and sometimes distant in time, for both those Harvard affiliated and those not. Both the scientific importance of the controversy around the MACH trial and its recency (Mitchell et al., 2020) may make its lead author Mukamal an exception here. Mukamal's influence is attested to by the various metrics and suggests the need for further focused study.

The alcohol industry continues to fund researchers in ways that are no longer possible for tobacco companies (Babor and Robaina, 2013; Mitchell and McCambridge, 2021; McCambridge and Mitchell, 2022). The tobacco and alcohol industries are connected in multiple ways, including through co-ownership (Bond et al., 2009; McCambridge et al., 2022) and they continue to collaborate in influencing science policy (McCambridge et al., 2019). Unfortunately, we know little about how they work together today to approach other strategically vital issues where the science is not entirely clear cut. This is important to rectify. In the interim it means that it is important to regard the alcohol research literature as having potentially been biased in similar ways to the tobacco literature due to evidence of shared origins (McCambridge et al., 2021). This means we should be particularly vigilant for interactions

Table 3
Most common authors in Subnetwork 16.

Author*	No of papers	Country Based	Years	Closeness centrality	Degree	Betweenness centrality	Harvard affiliated yes/no	If industry funding declared name of funder
Estruch, R.	9	Spain	1999–2015	0.609137	62	3150	No	FIVIN; Cerveceros de Espana, Assobirra, the Italian Association of the Beer and Malt Industries, ERAB, Beer and Health Foundation
Andres-lacueva, C.	5	Spain	2007–2013	0.418118	30	107	No	None identified
Sacanella, E.	5	Spain	2002–2012	0.517241	27	379	No	None identified
Fernandez-sola, J.	5	Spain	1999–2015	0.5	19	160	No	None identified
Lamuela-raventos. R. M.	5	Spain	2007–2015	0.436364	42	218	No	FIVIN, Cerveceros de Espana, ERAB, Beer and Health Foundation
Chiva-blanch, G.	4	Spain	2011–2015	0.412371	26	46	No	ERAB, FIVIN, Cerveceros de Espana; Assobirra
Urbano-marquez, A.	3	Spain	1999–2004	0.487805	13	76	No	None identified
Antunez, E.	3	Spain	2004–2007	0.502092	20	158	No	None identified
Ros, E.	3	Spain	2012–2015	0.412371	26	45	No	FIVIN; Beer and Health Foundation; ERAB; Cerveceros de Espana
Nicolas, J.M.	3	Spain	2002–2007	0.493827	16	85	No	None identified
Valderas-martinez, P	3	Spain	2013–2015	0.40404	20	9	No	ERAB, FIVIN, Cerveceros de Espana
Casas, R	3	Spain	2012–2015	0.40404	20	9	No	ERAB
Arranz, S	3	Spain	2012–2015	0.40404	20	9	No	ERAB

*This table is limited to all authors in subnetwork 16 with 3 or more publications.

between companies in organisational vehicles such as the International Center for Alcohol Policies (ICAP) (Jernigan, 2012; McCambridge et al., 2014) and the International Alliance for Responsible Drinking (IARD) (McCambridge et al., 2021). Such organisations were prohibited in the Master Settlement Agreement with tobacco companies due to their key roles in interfering with tobacco science and policy, and ICAP/IARD were centrally involved in organising the major alcohol companies to fund the MACH trial (Mitchell et al., 2020).

5. Conclusions

Contrary to the review-level findings (Golder and McCambridge, 2021), there is no strong evidence in this study that any possible alcohol industry influence on epidemiological research on alcohol and CVD has operated through co-authorship network formation. There are, nonetheless, patterns of alcohol industry funding identified here that are important to study further and thus require more fine-grained attention. It is suggested in particular that reliance on declared industry funding is too blunt a measure to capture roles and relationships with industry actors that may invite bias because it is inconsistent. The application of meta epidemiological approaches may benefit from being combined with insider perspectives on the features of alcohol research, informed by close scrutiny of the alcohol industry. It appears that reviews may warrant distinct attention from epidemiological studies, though paying attention to authors of both kinds of studies may be informative. It remains unclear whether and how far industry funding may be responsible for conflicting findings on alcohol and CVD, which are important to interrogate further in the interests of global health.

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Transparency statement: The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Patient and public involvement statement: Patients and the public were not involved in this study.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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References

Babor, T. F., & Robaina, K. (2013). Public health, academic medicine, and the alcohol industry's corporate social responsibility activities. *American Journal of Public Health, 103*(2), 206–214.

Barnes, D. E., & Bero, L. A. (1996). Industry-funded research and conflict of interest: An analysis of research sponsored by the tobacco industry through the Center for Indoor Air Research. *Journal of Health Politics, Policy and Law., 21*(3), 515–542.

Bero, L. A., Glantz, S., & Hong, M. K. (2005). The limits of competing interest disclosures. *Tob Control, 14*(2), 118–126.

Bes-Rastrollo, M., Schulze, M. B., Ruiz-Canela, M., & Martinez-Gonzalez, M. A. (2013). Financial conflicts of interest and reporting bias regarding the association between sugar-sweetened beverages and weight gain: A systematic review of systematic reviews PLoS Med. 2013;10(12):e1001578-e.

Bond, L., Daube, M., & Chikritzhs, T. (2009). Access to confidential alcohol industry documents: From 'Big Tobacco' to 'Big Booze'. *Australasian Medical Journal, 1*(3), 1–26.

Brandt, A. M. (2007). *The cigarette century: The rise, fall, and deadly persistence of the product that defined America*. Basic Books.

Carpenter, C. R., Cone, D. C., & Sarli, C. C. (2014). Using publication metrics to highlight academic productivity and research impact. *Academic Emergency Medicine, 21*(10), 1160–1172.
Della, M. V. (2011). 25 years of telepathology research: A bibliometric analysis. *Diagn Pathol., 6*(Suppl 1), S26.
Dunn, A. G., Arachi, D., Hudgins, J., Tsafnat, G., Coiera, E., & Bourgeois, F. T. (2014). Financial conflicts of interest and conclusions about neuraminidase inhibitors for influenza: An analysis of systematic reviews. *Annals of Internal Medicine, 161*(7), 513–518.
Estruch, R., & Hendriks, H. F. J. (2022). Associations between Low to moderate consumption of alcoholic beverage types and health outcomes: A systematic review. *Alcohol and Alcoholism, 57*(2), 176–184.
Fabbri, A., Holland, T. J., & Bero, L. A. (2018). Food industry sponsorship of academic research: Investigating commercial bias in the research agenda. *Public Health Nutrition, 21*(18), 3422–3430.
Fabbri, A., Lai, A., Grundy, Q., & Bero, L. A. (2018). The influence of industry sponsorship on the research agenda: A scoping review. *American Journal of Public Health, 108*(11), e9–e16.
Fekjaer, H. O. (2013). Alcohol-a universal preventive agent? A critical analysis. *Addiction, 108*, 2051–2057.
Fonseca, BdP., Sampaio, R. B., Fonseca, M. V. A., & Zicker, F. (2016). Co-authorship network analysis in health research: Method and potential use. *Health Research Policy and Systems, 14*(1), 34.
Golder, S., Garry, J., & McCambridge, J. (2020). Declared funding and authorship by alcohol industry actors in the scientific literature: A bibliometric study. *European Journal of Public Health, 30*(6), 1193–1200.
Golder, S., & McCambridge, J. (2021). Alcohol, cardiovascular disease and industry funding: a co-authorship network analysis of systematic reviews. *Social Science & Medicine, 289*, Article 114450.
González-Alcaide, G., Castelló-Cogollos, L., Castellano-Gómez, M., Agullo-Calatayud, V., Aleixandre-Benavent, R., Alvarez, F. J., et al. (2013). Scientific publications and research groups on alcohol consumption and related problems worldwide: Authorship analysis of papers indexed in PubMed and Scopus databases (2005 to 2009). *Alcoholism: Clinical and Experimental Research, 37*(Suppl 1), E381–E393.
González-Alcaide, G., Huamaní, C., Park, J., & Ramos, J. M. (2013). Evolution of coauthorship networks: Worldwide scientific production on leishmaniasis. *Revista da Sociedade Brasileira de Medicina Tropical, 46*(6), 719–727.
González-Alcaide, G., Park, J., Huamaní, C., Belinchón, I., & Ramos, J. M. (2015). Evolution of cooperation patterns in psoriasis research: Co-authorship network analysis of papers in medline (1942–2013). *PLoS One, 10*(12), e0144837.
González-Alcaide, G., Park, J., Huamaní, C., Gascón, J., & Ramos, J. M. (2012). Scientific authorships and collaboration network analysis on Chagas disease: Papers indexed in PubMed (1940–2009). *Revista do Instituto de Medicina Tropical de São Paulo, 54*(4), 219–228.
Griswold, M. G., Fullman, N., Hawley, C., Arian, N., Zimsen, S. R. M., Tymeson, H. D., et al. (2018). Alcohol use and burden for 195 countries and territories, 1990–2016: A systematic analysis for the Global Burden of Disease Study 2016. *Lancet, 392*(10152), 1015–1035.
Grundy, Q., Dunn, A. G., Bourgeois, F. T., Coiera, E., & Bero, L. (2018). Prevalence of disclosed conflicts of interest in biomedical research and associations with journal impact factors and altmetric scores. *JAMA, 319*(4), 408–409.
Gutiérrez-Vela, M. M., Díaz-Haro, A., Berbel-Salvador, S., Lucero-Sánchez, A., Robinson-García, N., & Cutando-Soriano, A. (2012). Bibliometric analysis of research on regenerative periodontal surgery during the last 30 years. *Journal of Clinical and Experimental Dentistry, 4*(2), e112–e118.
Hansen, C., Lundh, A., Rasmussen, K., & Hróbjartsson, A. (2019). Financial conflicts of interest in systematic reviews: Associations with results, conclusions, and methodological quality. *Cochrane Database of Systematic Reviews, 8*.
Jernigan, D. H. (2012). Global alcohol producers, science, and policy: The case of the international center for alcohol policies. *American Journal of Public Health, 102*(1), 80–89.
Koseoglu, M. A. (2016). Growth and structure of authorship and co-authorship network in the strategic management realm: Evidence from the Strategic Management Journal. *BRQ Business Research Quarterly., 19*(3), 153–170.
Lundh, A., Lexchin, J., Mintzes, B., Schroll, J.B., Bero, L. (2017). Industry sponsorship and research outcome Cochrane Database Syst Rev. 2(2):Mr000033.
Mandrioli, D., Kearns, C. E., & Bero, L. A. (2016). Relationship between research outcomes and risk of bias, study sponsorship, and author financial conflicts of interest in reviews of the effects of artificially sweetened beverages on weight outcomes: A systematic review of reviews. *PLoS One, 11*(9), e0162198.
Manthey, J., Shield, K. D., Rylett, M., Hasan, O. S. M., Probst, C., & Rehm, J. (2019). Global alcohol exposure between 1990 and 2017 and forecasts until 2030: A modelling study. *Lancet., 393*(10190), 2493–2502.
McCambridge, J. M. (2018). Alcohol industry involvement in science: A systematic review of the perspectives of the alcohol research community. *Drug and Alcohol Review, 37*(5), 565–579.
McCambridge, J., Daube, M., & McKee, M. (2019). Brussels Declaration: A vehicle for the advancement of tobacco and alcohol industry interests at the science/policy interface? *Tob Control., 28*(1), 7–12.
McCambridge, J., Garry, J., Kypri, K., & Hastings, G. (2022). "Using information to shape perception": Tobacco industry documents study of the evolution of Corporate Affairs in the Miller Brewing Company. *Globalization & Health*.
McCambridge, J., Garry, J., & Room, R. (2021). The origins and purposes of alcohol industry social aspects organizations: Insights from the tobacco industry documents. *Journal of Studies on Alcohol and Drugs, 82*(6), 740–751.
McCambridge, J., & Hartwell, G. (2015). Has industry funding biased studies of the protective effects of alcohol on cardiovascular disease? A preliminary investigation of prospective cohort studies. *Drug and Alcohol Review, 34*(1), 58–66.
McCambridge, J., Kypri, K., Drummond, C., & Strang, J. (2014). Alcohol harm reduction: Corporate capture of a key concept. *PLoS Medicine, 11*(12), e1001767.
McCambridge, J., Mialon, M., & Hawkins, B. (2018). Alcohol industry involvement in policymaking: A systematic review. *Addiction., 113*, 1571–1584.
McCambridge, J., & Mitchell, G. (2022). The views of researchers on the alcohol industry's involvement in science: Findings from an interview study. *European Addiction Research*. https://doi.org/10.1159/000522603
McGarity, T. O., & Bending, W. WE. (2012). *Science: How Special Interests Corrupt Public Health Research*.
Mitchell, G., Lesch, M., & McCambridge, J. (2020). Alcohol industry involvement in the moderate alcohol and cardiovascular health trial. *American Journal of Public Health, 110*(4), 485–488.
Mitchell, G., & McCambridge, J. (2021). The 'snowball effect': Short and long-term consequences of early career alcohol industry research funding. *Addiciton Research & Theory*.
Moynihan, R., Bero, L., Hill, S., Johansson, M., Lexchin, J., Macdonald, H., et al. (2019). Pathways to independence: Towards producing and using trustworthy evidence. *BMJ, 367*, Article l6576.
Moynihan, R., Lai, A., Jarvis, H., Duggan, G., Goodrick, S., Beller, E., et al. (2019). Undisclosed financial ties between guideline writers and pharmaceutical companies: A cross-sectional study across 10 disease categories. *BMJ Open, 9*(2), e025864.
Naimi, T. S., Babor, T., Chikritzhs, T., Stockwell, T. R., McCambridge, J., Miller, P., et al. (2015). Let's not "relax" evidence standards when recommending risky preventive therapeutic agents. *Alcoholism: Clinical and Experimental Research, 39*(7), 1275–1276.
Naimi, T. S., Xuan, Z., Brown, D. W., & Saitz, R. (2013). Confounding and studies of 'moderate' alcohol consumption: The case of drinking frequency and implications for low-risk drinking guidelines. *Addiction., 108*(9), 1534–1543.
Newman, M. E. J. (2004). Coauthorship networks and patterns of scientific collaboration. *Proceedings of the National Academy of Sciences, 101*(suppl 1), 5200–5205.
Oppenheimer, G. M., & Bayer, R. (2020). Is moderate drinking protective against heart disease? The science, politics and history of a public health conundrum. *Milbank Quarterly., 98*(1), 39–56.
Oreskes, N., & Conway, E. M. (2010). *Merchants of doubt: how a handful of scientists obscured the truth on issues from tobacco smoke to global warming*. London: Bloomsbury Press.
Popp, J. B., Oláh, J., Kot, S., Harangi Rákos, M., & Lengyel, P. (2018). Social network analysis of scientific articles published by food policy. *Sustainability., 10*, 577.
Proctor, R. N. (2012). The history of the discovery of the cigarette-lung cancer link: Evidentiary traditions, corporate denial, global toll. *Tob Control., 21*(2), 87–91.
Rasmussen, K., Bero, L., Redberg, R., Gøtzsche, P. C., & Lundh, A. (2018). Collaboration between academics and industry in clinical trials: Cross sectional study of publications and survey of lead academic authors. *BMJ, 363*, Article k3654.
Roerecke, M., & Rehm, J. (2012). The cardioprotective association of average alcohol consumption and ischaemic heart disease: A systematic review and meta-analysis. *Addiction, 107*(7), 1246–1260.
Rubin, E. (2014). To drink or not to drink: That is the question. *Alcoholism: Clinical and Experimental Research, 38*(12), 2889–2892.
Savell, E., Fooks, G., & Gilmore, A. B. (2016). How does the alcohol industry attempt to influence marketing regulations? A systematic review. *Addiction., 111*(1), 18–32.
Schick, S. F., & Glantz, S. A. (2007). Old ways, new means: Tobacco industry funding of academic and private sector scientists since the Master Settlement Agreement. *Tob Control, 16*(3), 157–164.
Stockwell, T., Zhao, J., Panwar, S., Roemer, A., Naimi, T., & Chikritzhs, T. (2016). Do, "moderate" drinkers have reduced mortality risk? A systematic review and meta-analysis of alcohol consumption and all-cause mortality. *Journal of Studies on Alcohol and Drugs, 77*(2), 185–198.
Vanni, T., Mesa-Frias, M., Sanchez-Garcia, R., Roesler, R., Schwartsmann, G., Goldani, M. Z., et al. (2014). International scientific collaboration in HIV and HPV: A network analysis. *PLoS One., 9*(3), e93376.
Vos, M., van Soest, A. P. M., van Wingerden, T., Janse, M. L., Dijk, R. M., Brouwer, R. J., et al. (2020). Exploring the influence of alcohol industry funding in observational studies on moderate alcohol consumption and health. *Advances in Nutrition, 11*(5), 1384–1391.
Yu, Q., Shao, H., He, P., & Duan, Z. (2013). World scientific collaboration in coronary heart disease research. *International Journal of Cardiology, 167*(3), 631–639.