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Manufacturing doubt: Assessing the effects of independent vs industry-sponsored messaging about the harms of fossil fuels, smoking, alcohol, and sugar sweetened beverages

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ABSTRACT

Background Manufacturers of harmful products engage in misinformation tactics long employed by the tobacco industry to emphasize uncertainty about scientific evidence and deflect negative attention from their products. This study assessed the effects of one type of tactic, the use of "alternative causation" arguments, on public understanding. Methods In five trials (one for each industry) anonymized Qualtrics panel respondents were randomized to receive a message on the risk in question from one of four industry sponsored organizations (exposure), or from one of four independent organizations (control), on risks related to alcohol, tobacco, fossil fuel and sugar sweetened beverages. Logistic regression models were used to evaluate the effect of industry arguments about uncertainty on the primary outcome of public certainty about product risk, adjusting for age, gender and education. The results from all five trials were pooled in a random-effects meta-analysis. Findings In total, n=3284 respondents were exposed to industry-sponsored messaging about product-related risks, compared to n=3297 exposed to non-industry messages. Across all industries, exposure to industry-sponsored messages led to greater reported uncertainty or false certainty about risk, compared to non-industry messages [Summary odds ratio (OR) 1·60, confidence interval (CI) 1·28–1·99]. The effect was greater among those who self-rated as not/slightly knowledgeable (OR 2·24, CI 1·61–3·12), or moderately knowledgeable (OR 1·85, CI 1·38–2·48) compared to those very/extremely knowledgeable (OR 1·28, CI 1·03–1·60). Conclusions This study demonstrates that exposure to industry sponsored messages which appear intended to downplay risk significantly increases uncertainty or false certainty, with the effect being greater in less knowledgeable participants.

1. Introduction

The COVID-19 pandemic increased pre-existing concern about the impact of misinformation, with the World Health Organization joining other United Nations agencies in calls to mitigate its harms (The Lancet Infectious D., 2020; World Health Organisation, 2020). Beyond COVID-19, some of the most entrenched health and misinformation issues facing humanity are in part a result of the activities of commercial actors. This is particularly the case where the profit motive, pursued by large corporate actors, is at odds with the public good, as in the case of the tobacco, alcohol, fossil fuel (Supran & Oreskes, 2021) or sugar-sweetened beverage (SSB) industries (Michaels, 2008; Oreskes & Conway, 2012). In these instances, not only are such companies vectors of disease (McKee & Stuckler, 2018; Moodie et al., 2013), but also have the means and the motive to be powerful vectors of misinformation. This is particularly the case in an era where it is exceptionally easy to spread erroneous or pseudoscientific information (Loomba, de Figueiredo, Piatek, de Graaf & Larson, 2021; Wang et al., 2019).

The tobacco industry provides the most well-documented example of commercially-driven misinformation. Internal tobacco industry documents have revealed that it had sought explicitly to promote ambiguity and misinformation about the harms associated with cigarettes. These messages are perpetuated through funding corporate responsibility efforts, researchers, conferences, and academic journals, and creating

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misleading public information campaigns, all with the goal of increasing doubt and uncertainty (Bero, 2003; Brownell & Warner, 2009; Grüning et al., 2006; Hirschhorn, 2004; Muggli et al., 2003; Ong & Glantz, 2001).

Such misinformation is often promoted using "alternative causation" arguments. This type of argument seek to attribute a range of alternative potential causes for a disease other than the product in question, in a way that obscures or dilutes the independent causal contribution of a product (Proctor, 2012). This is most clearly seen in the tobacco industries alternate causation strategy, in which tobacco was claimed to be only one of many potential causes of cancer, including stress, personality factors (Petticrew et al., 2012), pollution, green tea, keeping birds and many other factors (Proctor, 2012). Creating doubt through alternative causation arguments forms an important component of product defense. It also shifts the blame on to individual consumers who can be said to have been 'warned' about the risks (Proctor, 2012; Supran & Oreskes, 2021) and reduces the potential risk of public demands for regulation that might otherwise reduce sales (Bero, 2003). As an internal tobacco industry memo notoriously read: "Doubt is our product … … since it is the best means of competing with the 'body of fact' that exists in the minds of the general public." (Michaels, 2008).

Internal memos have revealed that the tobacco industry not only developed a range of campaigns with the intention of promoting alternative causation arguments, but also evaluated their impact. In one case, an executive of the Tobacco Institute, an industry front group, claimed that in test audiences, their film entitled "Smoking and Health: The Need to Know" had generated "… large and significant shifts in attitudes favourable to the industry." (Proctor, 2011) Such misinformation can be extremely hard for members of the public to identify, especially when it is scientific in tone (Loomba et al., 2021), and when the message sponsor is not clear. This is because corporate misinformation frequently comprises a mixture of true and false information, contains subtle nudges towards uncertainty (Petticrew et al., 2020), and sometimes refers to scientific, medical or government sources that are seen as trustworthy by the public.

A wider body of evidence is now emerging on similar tactics pursued by other corporate actors producing harmful products, including those producing fossil fuels (Supran GO, 2017), alcohol (Petticrew et al., 2020; Lim et al., 2019a; Petticrew et al., 2018), and sugar-sweetened beverages (Kearns et al., 2016). For example, a majority of advertorials appearing in leading US newspapers commissioned by a fossil fuel company were found to cast doubt on the causes of climate change, even as internal company memos accepted the links between fossil fuels and global warming (Supran GO, 2017). Similarly, alcohol-industry-sponsored charities have been found to use alternative causation arguments to dispute the independent links between alcohol and cancer (Petticrew et al., 2018), and the risks from drinking during pregnancy (Lim et al., 2019b).

While there is strong strategic coherence among such industry misinformation and other parallel tactics, there is very limited information on the effects of this type of misinformation on the public. To address this gap, we conducted trials in which online panels were randomly exposed either to industry-sponsored alternative causation messages on the harms of fossil fuels, cigarettes, alcohol and sugar-sweetened beverages, or to factually accurate information on the same topic from an independent authority. Herein we use the term 'industry-sponsored' to represent content distributed directly by a given industry or by organizations in receipt of industry funding. The primary outcomes of interest were the percentage of respondents reporting that they are either uncertain about the product risk, or are certain there is no risk, after being presented with industry-sponsored vs non-industry-sponsored information.

2. Methodology

2.1. Study design

Online survey panels were randomized to be exposed to a statement about a product-related harm sourced from either an industry-sponsored organization or an independent organization.

2.2. Selection of intervention text

We identified examples of alternate causation arguments from the alcohol, tobacco, sugary drinks and fossil fuels industries or national/international organizations funded by these industries (see Supplementary Table 1). These related to (i) smoking and lung cancer; (ii) the effect of alcohol consumption on risk of breast cancer; (iii) the effect of alcohol consumption on pregnancy harms; (iv) the contribution of SSBs to obesity; and (v) the contribution of fossil fuels to climate change. We included tobacco industry misinformation on the link between smoking and lung cancer to explore whether it still influenced public (mis)understanding. Alternate causation arguments were identified from analyses of a given industry in the academic literature, from consultations with experts, and from our own research.

2.3. Study participants

The surveys were administered online to a Qualtrics standing panel of UK adults (Qualtrics, Provo, UT). Participants in the standing panel were emailed by Qualtrics and invited to take part in the survey and then presented with information about the study and an online consent form. Having read this, if they agreed to participate, they proceeded to take part in the online survey. The eligibility criteria were (i) adult (aged 18+) (ii) currently living in the UK (Czeisler et al., 2020). In effect, this study involved five separate randomized controlled trials, each comparing the effect of industry-sponsored vs non-industry information on respondents' certainty about specific risks.

2.4. Sample

An initial pilot study (n = 120) suggested that presenting alcohol industry misinformation about cancer would increase the proportion of people who report being uncertain about the evidence by approximately 10%. Power calculations ($\alpha = 0{\cdot}05$, power of 0·80) and the pilot study suggested that a minimum of n = 640 respondents were needed (n = 320 in the 'intervention' arm, who were presented with an example of industry-sponsored misinformation, and n = 320 in a control arm, who were presented with independent information).

2.5. Primary and secondary outcomes

The primary outcomes were the percentage of respondents reporting that they were *uncertain about the risk*, and those who reported they *are certain there is no risk*, after being presented with a piece of industry-sponsored or non-industry-sponsored information.

We also hypothesized that misleading alternate causation arguments may also affect trust in scientists more generally (Gustafson & Rice, 2020). The secondary outcomes were therefore (i) trust in scientists to find out accurate information about the world; and (ii) trust in scientists to find out accurate information about what we eat and drink. This question is adapted from the Wellcome Global Monitor on trust in science (Wellcome Trust. Wellcome, 2019).

2.6. Survey

Participants were first presented with information about the study and asked to confirm their agreement to participate in the survey. They were subsequently presented with a short, anonymized, paragraph

containing either an alternative causation argument about a particular harm obtained from one of the four industry-sponsored sources (randomly selected from examples from either the fossil fuels, smoking, alcohol, or sugar sweetened beverages industries), or information from an independent scientific or non-governmental agency (see Table 1 in supplementary information for full list of paragraphs used). Respondents were then asked about their certainty about the risk of the specific harm from that product (certain it does increase risk, uncertain it increases risk, certain it doesn't increase risk). The final questions asked about trust in scientists. In the alcohol survey we included three AUDIT-C (Alcohol Use Disorders Identification Test) questions (see Supplementary Table 2) which assess level of alcohol consumption and frequency of drinking occasions. At the end of the survey respondents were presented with accurate independent (non-industry) information, and a link to a trusted source (e.g., the relevant NHS England information or other independent source). Each respondent was exposed to misinformation from only one industry.

2.7. Ethics

Ethical approval was obtained from London School of Hygiene & Tropical Medicine (LSHTM) Observational/Interventions Research Ethics Committee and the study protocol was registered with the Open Science Framework (https://osf.io/kwv4x/).

2.8. Statistical analysis

For the primary endpoint, logistic regression models were used to compare the effect of industry-sponsored vs non-industry messages on the binary outcome of "uncertain it increases the risk/certain it doesn't increase risk" vs "certain it does increase risk", adjusted for sex, age, and education. Trial results were pooled in a random-effects meta-analysis. We also present results from similar analyses stratified by sex for topics related to pregnancy and breast cancer, as well as by baseline self-reported level of knowledge for all topics. Analyses were performed in StataSE 15 (College Station, TX: StataCorp LLC).

3. Results

In total, across all paired comparisons, n = 3284 respondents were randomized to industry-sponsored texts from one of the four industries, and n = 3297 to non-industry messages about the harm in question, randomly selected from one of the four independent organizations (Table 1).

Overall, (i.e. grouping all industries together) industry-sponsored uncertainty messages significantly increased the odds of uncertainty, or false certainty, by 60%, compared to independent sources of information (Summary OR 1·60, 95% CI 1·28–1·99) (see Fig. 1 and Table 2).

The increase in uncertainty/false certainty was found across all industries, though for the trials exploring the messaging on sugary drinks and obesity (OR 1·26, 95% CI 0·99–1·60), and alcohol and pregnancy (OR 1·29, 95% CI 0·97–1·72), the association did not reach statistical significance. The increase in odds ranged from an increase of 26% for sugary drinks and risk of obesity, to 142% for smoking and lung cancer (see Fig. 2). The increase in odds of uncertainty/false certainty relating to the link between fossil fuels and climate change was 67%, and for alcohol and pregnancy harms was 29%. Looking at uncertainty alone, across all industries, industry messages were also associated with significant greater uncertainty (Z = 2·88; 27·8% vs 20·6%; C.I. of difference 2·3–12·1; p = 0.002).

We analysed the findings stratified by sex, and by baseline level of self-reported knowledge in the topic area. For alcohol and breast cancer, industry-sponsored messaging significantly increased the odds of uncertainty or false certainty for both men (OR 1·63, 95% CI 1·03-2·60) and women (OR 1·55, 95% CI 1·17-2·05). For alcohol and pregnancy, industry misinformation significantly increased the odds for women (OR 1·58, 95% CI 1·07-2·34) but not men (OR 0·99, 95% CI 0·63-1·57). The effect was larger for those with less knowledge at baseline (i.e. those who self-rated as not/slightly knowledgeable (OR 2·24, 95% CI 1·61–3·12) (see Fig. 3). Exposure to industry-sponsored messages did not affect any measure of change in trust in science.

Those drinking alcohol at lower risk appeared more influenced by alcohol industry-sponsored texts, compared to those drinking at higher risk, in respect to their uncertainty that alcohol is a risk factor for breast cancer (low risk drinkers: OR 1·74, 95% CI 1·28–2·35, high risk drinkers OR 1·35, 95% CI 0·92–2·00) and alcohol as a risk factor during pregnancy (low risk drinkers: OR 1·52, 95% CI 1·05, 2·20, high risk drinkers OR 0·96, 95% CI 0·60, 1·53).

Table 1
Baseline characteristics.

	Industry, n (%)	Non-industry, n (%)	Total, n (%)
AGE			
18–35 years	2011 (61.2)	1974 (60.0)	3985 (60.6)
36–54 years	935 (28.5)	965 (29.3)	1900 (28.9)
55–64 years	228 (6.9)	227 (6.9)	455 (6.9)
65+ years	110 (3.4)	127 (3.9)	237 (3.6)
Sex			
Male	1061 (32.3)	1053 (32.0)	2114 (32.1)
Female	2148 (65.4)	2158 (65.5)	4306 (65.5)
Other/prefer not to say	74 (2.3)	85 (2.6)	159 (2.4)
EDUCATION			
University degree or higher	1051 (32.0)	1076 (32.7)	2127 (32.4)
Qualification below university degree	651 (19.8)	649 (19.7)	1300 (19.8)
Upper secondary	979 (29.8)	977 (29.7)	1956 (29.8)
Up to lower secondary	600 (18.3)	592 (18.0)	1192 (18.1)
KNOWLEDGE			
Very/extremely knowledgeable	1595 (48.6)	1557 (47.2)	3152 (47.9)
Moderately knowledgeable	1247 (38.0)	1316 (39.9)	2563 (39.0)
Not/slightly knowledgeable	442 (13.5)	424 (12.9)	866 (13.2)
TRUST IN SCIENCE IN GENERAL			
A lot	1327 (40.4)	1412 (42.8)	2739 (41.6)
Some	1729 (52.7)	1640 (49.7)	3369 (51.2)
Not much	165 (5.0)	175 (5.3)	340 (5.2)
Not at all	60 (1.8)	70 (2.1)	130 (2.0)
TRUST IN SCIENCE (SPECIFIC)			
A lot	1271 (38.7)	1348 (40.9)	2619 (39.8)
Some	1705 (52.0)	1610 (48.9)	3315 (50.4)
Not much	233 (7.1)	267 (8.1)	500 (7.6)
Not at all	72 (2.2)	69 (2.1)	141 (2.1)

4. Discussion

This study shows that industry-sponsored information leads to significantly greater uncertainty - or false certainty - about the risks posed by harmful products compared to independent information. This difference is largest where participants' prior knowledge is moderate or low. The misinformation effects are greatest in relation to the links between alcohol and breast cancer, and between fossil fuels and climate change. The overall effect of industry misinformation is large, increasing the odds of an inaccurate perception of the risk by around 60%.

These findings are comparable to the effect sizes reported in a non-randomized tobacco industry study reported in the internal tobacco

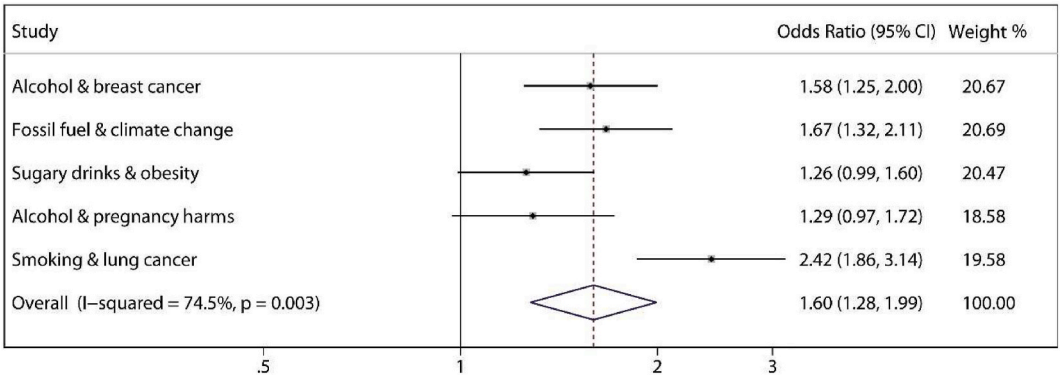

Fig. 1. Association of exposure to industry-sponsored messaging with being uncertain the risk factor causes the harm, or certain that the risk factor does not cause the harm.
CI, confidence interval. Models adjusted for age, sex, and education.

Table 2
Primary outcome of certainty regarding products link to specific risk, following exposure to industry or non-industry-sponsored text.

	Industry text n (%)	Non-industry text n (%)
	n = 2511	n = 2521
Certain it doesn't increase risk	384 (15.3)	377 (15.0)
Uncertain it does increase risk	697 (27.8)	520 (20.6)
Certain it does increase risk	1430 (57.0)	1624 (64.4)

industry documents regarding changes in attitudes after test audiences were exposed to misleading information on tobacco and health harms (Proctor, 2011). They are also consistent with the size of reported declines in vaccine uptake following exposure to factual or misleading vaccine information (Loomba et al., 2021). It should also be noted that the effects measured in our study represent but one small component of the potential overall impact of industry-related strategies, because the provision of health information through a given organization or forum represents just one part of a multi-faceted approach adopted by industries to shape information environments as well as public discourse. These complementary industry strategies are likely to act through diverse and synergistic mechanisms that serve to maintain doubt and uncertainty in the public's mind.

We observed differences in effect size and level of baseline uncertainty across the different health topics, even though the effects are all in the same direction. This suggests that the impact of misinformation may not be same across all topics and groups, but rather may depend on initial levels of public understanding. Despite this, there was a clear trend towards greater uncertainty arising from industry-sponsored information, showing that the alternative causation arguments used by industry and industry-funded organizations are generally effective, and their effects are achieved by increasing levels of uncertainty in the mind of the public.

This is particularly important where baseline knowledge is low, and so misinformation can be more potent. A recent (Lee et al., 2009) study found that among women attending breast cancer screening services, only 19·5% could identify alcohol as an independent risk factor for breast cancer (Sinclair et al., 2019), even though alcohol consumption has been estimated to cause around 15–16% of all breast cancer deaths in the US. (Nelson et al., 2013) Similarly, a survey from the Pew Research Center, a non-partisan think tank, reported that belief about the link between human activity and climate change remains at less than 25% among Republican voters in the US. (PEW Research Center. 4, 2016) In our own analysis, we found that among those who self-reported low knowledge in the topic beforehand, the effects were greater. However, when considering the baseline levels of certainty/uncertainty for each topic dyad, we see that the largest effect sizes were not necessarily where baseline uncertainty was greatest.

Our findings on level of prior knowledge are relevant in the context of existing inequalities. Tobacco, processed-food and alcohol companies have been found to target their marketing at those ethnic and socio-economic minority groups who already consume at more harmful levels, or have a lower level of knowledge about the harms (Brown--Johnson et al., 2014; Du et al., 2018; Hackbarth et al., 1995;

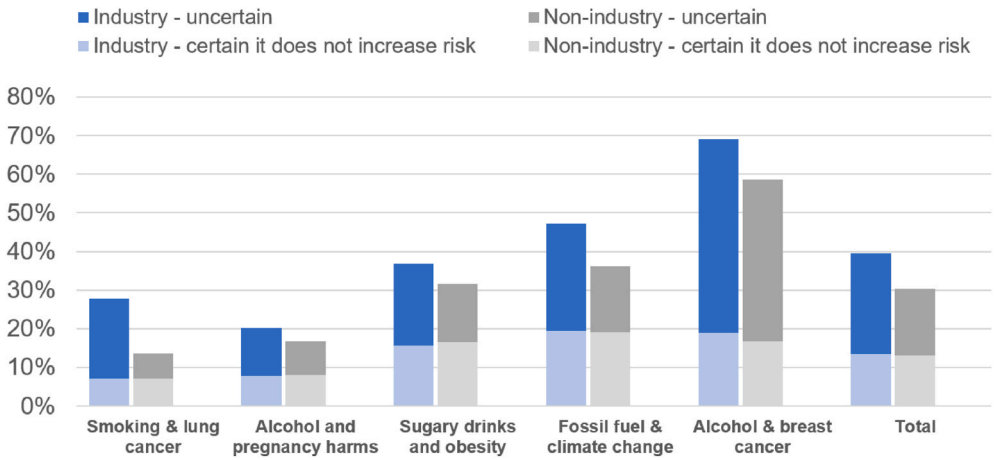

Fig. 2. Comparison of uncertainty the risk factor causes the harm, or certainty that the risk factor does not cause the harm, after exposure to industry or non-industry-sponsored messages by domain and overall.

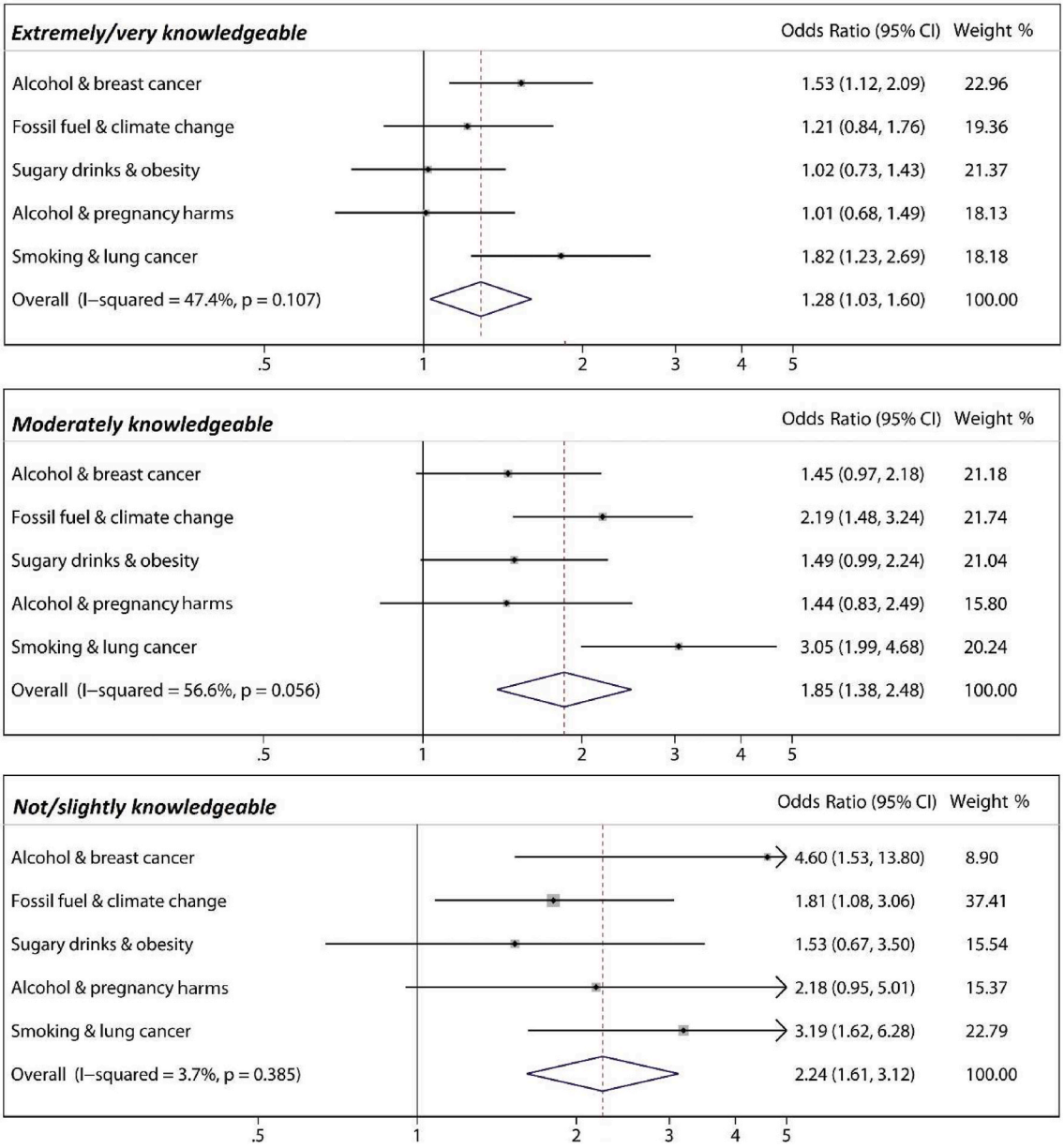

Fig. 3. Association of exposure to industry-sponsored messaging with being uncertain the risk factor causes the harm, or certain that the risk factor does not cause the harm, by prior self-reported level of knowledge on the topic.
CI, confidence interval. Models adjusted for age, sex, and education.

MaaniHessari et al., 2019). The same groups are more likely to be affected by the health impacts of industry products and practices, including tobacco, alcohol, SSBs and climate change. The forms of misleading misinformation, and the observations that the impact is greatest among those who are moderately or slightly knowledgeable, suggested that information campaigns that include a counter-marketing component that expose the strategies adopted by industries to undermine public knowledge may be particularly important.

The main strength of this study is that it is the first independent assessment of the effectiveness of industry misinformation, with direct comparisons across a range of industries which affect public health. The study also shows that the effects of industry misinformation on uncertainty have now been shown directly and experimentally, as opposed to inferred (e.g. from industry documents).

The limitations of this study include the relatively small range of excerpts tested, and the potential selection bias in the panels due to their online nature. Certainly, there may be other excerpts from the same materials that may have been more or less misleading, but fundamentally, such alternative causation arguments should not be present in materials which claim to communicate health risk from products, and so it is reasonable to use excerpts from these materials to assess effects. We are not claiming, and nor does this analysis rely on assuming, that the excerpts used for the study are representative of all materials produced by industry and their funded organizations. Our aim is to measure the impacts of being exposed to what are known problematic and concerning examples of the type of misinformation provided by such organizations.

Also, beyond the AUDIT-C question for alcohol, which suggested a weak association between consumption level and vulnerability to misinformation, we did not measure differences in certainty based on consumption patterns e.g. those who consume SSBs vs those who do not, and those who take or advocate for climate change action – such differences have been seen in previous surveys between those who smoke and those who do not, even differences between smoking filtered vs non-

filtered cigarettes (Proctor, 2012). If this finding can be generalized, it means that more nuanced/targeted approaches to public health messaging are needed to reach different audiences and to counter misinformation.

The potency of this misinformation is of concern in part because exposure to it is widespread. Compared to the tobacco industry, which has now been prevented from many forms of public engagement, the fossil fuel, alcohol, and sugar sweetened beverage industries have far wider access to the public as conveyors of misinformation, including by funding charities with the express purpose of communicating on product harms to the general public, as well as to children and young people through schools (Miller et al., 2011; Madureira Lima and Galea, 2018; Gross, 2018; Steele et al., 2019; Jackson & Dixon, 2020). By way of example, Drinkaware, an alcohol-industry-sponsored charity in the UK, whose misinformation is used in two of our examples, is named on most alcohol-related advertising labels, posters and adverts, and its website, from which the information used in this study was obtained, received over 10 million unique visitors in 2018 (DrinkAware. Impact Report, 2018). Just as "the dose makes the poison", the impact of these messages is a function of both their potency, and their breadth of exposure.

5. Conclusion

The role of powerful commercial actors in perpetuating misinformation that aligns with their strategic objectives is seriously overlooked. Our findings build on a growing body of evidence that demonstrates the fallacy of "tobacco exceptionalism", with a range of harmful product manufacturers exhibiting similar strategies and approaches. This evidence brings into question whether manufacturers of harmful products and charities with funding from such manufacturers should be permitted to communicate about health risks with the public. This question deserves much greater attention considering the effect, and the scale of these interventions, and the conflicts of interest between the public good, and the disproportionate harm on which revenues from these industries rely. Future research could focus on messages regarding other harmful products such as gambling or vaping. Further research is also needed on the ways, and extent, to which such information drives behaviours, including consumption habits, and how both regulatory approaches and counter-marketing efforts might be designed to reduce this influence.

However the more pressing need is to consider regulatory and other countermeasures to combat this misinformation, as is being increasingly advocated for online misinformation more generally.

Author statement

MP, MVS, NM and CK conceptualised the study together and CK and MP acquired the funding. MP, CK, MvS, FF and NM developed the data analysis plan and MP, CK, MvS, and NM identified the quotes used. FF performed the formal analysis and generated the figures. NM led on writing and wrote the first draft, with all authors contributing to subsequent drafts equally. MP has verified the data. The data collection was supported through the UKRI Quality-related Research Strategic Priorities Fund (QR-SPF).

Ethics

Ethical approval was obtained from London School of Hygiene & Tropical Medicine (LSHTM) Observational/Interventions Research Ethics Committee and the study protocol was registered with the Open Science Framework (https://osf.io/kwv4x/).

Disclosure statement

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Declaration of competing interest

The authors declare no relevant conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2021.101009.

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