Opposition to banning cigarette filters and the belief that removing filters makes cigarettes much more harmful among adults who smoke: Findings from the 2022 International Tobacco Control Four Country Smoking and Vaping Survey

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Abstract

Introduction: In line with historical tobacco industry marketing claims, many consumers perceive cigarettes with filters as less harmful than cigarette without filters. However, scientific evidence indicates that cigarette filters do not reduce the risks associated with smoking. We examined opposition to banning the sale of cigarettes with filters, beliefs about whether removing filters makes cigarettes much more harmful, and whether this belief is associated with opposition to banning filters among adults who smoke cigarettes from four high-income countries.

Methods: Data are from 2,980 adults who smoke cigarettes and participated in the 2022 ITC Smoking and Vaping Survey in Australia, Canada, England, and the United States (US). Weighted descriptives estimated opposition to a cigarette filter ban and the belief that removing filters makes cigarettes 'much more', 'a little more', 'not more' harmful, or 'don't know'. Adjusted regression analyses examined the association between opposition to banning filters (vs. support/don't know) and the belief that removing filters would make cigarettes much more harmful (vs. otherwise).

Results: Across all counties, 69.3% opposed banning filters, 11.5% of respondents supported banning filters, and 19.1% did not know (main effect for country differences: p=0.001). Country differences remained significant after adjusting for covariates (p=0.047), with adults who smoke in Australia and the US being significantly more likely to oppose a filter ban than those in England. Canada did not differ significantly from any of the countries. Nearly half (45.9%) believe that removing filters would make cigarettes much more harmful, 28.6% reported a little more harmful, 15.3% were unsure, and 10.2% reported not more harmful (country differences: p=0.002). Country differences were no longer significant after adjustment (p=0.18). Believing that removing filters makes cigarettes much more harmful was strongly associated with opposing a filter ban (78.5%) (vs. otherwise: 62.1%, p<0.001).

Conclusions: Across all four countries, three-quarters of adults who smoke erroneously believe that removing filters would make cigarettes more harmful, and believing that doing so would make cigarettes much more harmful was the strongest predictor of opposing a filter ban.

Key words: Cigarettes, filters, public health, opposition, perceptions of harm, tobacco industry.

Implications: More than 90% of manufactured cigarettes worldwide contain filters. Contrary to marketing claims by the tobacco industry, cigarette filters do not offer any health protection from cigarette smoke; however, three-quarters of adults who smoke erroneously believe that cigarettes with filters are much less harmful than cigarettes without filters. To protect public health and the environment, the World Health Organization has recommended that policymakers consider banning cigarette filters as they are unnecessary single use plastics.

Introduction

As scientific evidence was emerging in the 1950s on the harmfulness of cigarettes,[1,2] the tobacco industry introduced the 'accessory filter' to convince the public and governments that they were taking action to make cigarettes safer for consumers (e.g., claiming that filters reduced nicotine, tar and other toxicants when inhaling smoke).[3-10] Filter-tip cigarettes accounted for only 1.4% of sales in 1952, increased to over 40% by the end of the 1950s,[8] and reached 60% by 1965.[11,12] Then in the 1970s, "light" and "mild cigarette" brand varieties with ventilated filters were heavily marketed, increasing the palatability of smoking, and reducing consumer perceptions of smoking-related risks.[13-17]

Several early epidemiological studies showed apparent benefits of filter-tip cigarettes over unfiltered cigarettes, including lower risk of lung cancer and all-cause mortality.[12] However, subsequent epidemiological data have shown that ventilated and unventilated filter-tip cigarettes were not less harmful than unfiltered cigarettes.[4,12,13,18,19] In fact, the relative risks for lung cancer among people who smoke has increased over the last sixty years as filter-tip cigarettes became dominant.[19-21] More specifically, over the last several decades, there has been a significant increase in lung adenocarcinoma incidence, displacing squamous cell carcinoma as the predominant type of lung cancer,[19-23] with evidence showing that ventilated filters contributed to the rise in lung adenocarcinomas among people who smoke.[19,21,22] Early studies had several limitations, which are likely to account for the discrepancy with later studies. First, earlier studies failed to adjust for the change in cigarette stick design features, notably that cigarettes with a filter reduced the amount of tobacco in the stick, thus reducing the amount of toxic smoke constituents inhaled.[12,19,23-25] Second, the addition of the filter and ventilation holes changed the way people smoked, resulting in compensatory behaviours such as greater puff volume, longer puff length, deeper inhalation, and increased cigarette consumption.[4,12,13,15,16,19,21-23,26] Third, the addition of filters resulted in people inhaling fibers and microplastics from filters that embed into

their lungs (synthetic plastic cellulose acetate became the most common type of material used in manufactured cigarette filters[15]).[27,28] Fourth, filters, with and without ventilation, alter cigarette combustion, resulting in greater exposure to tobacco-specific nitrosamines that increase the risk of lung adenocarcinoma.[22, 24,29-31] Notably, filters are also ineffective at removing gases of low molecular weight, such as carbon monoxide.[29] Despite being labelled the "deadliest fraud in the history of human civilization",[25] by 1990, over 90% of manufactured cigarettes globally contained cigarette filters.[7]

In addition to accessory filters failing to provide any real health protection, discarded cellulose acetate filters may have adverse ecotoxicological effects because they do not easily biodegrade, thereby contributing to environmental plastic pollution.[32,33] The World Health Organization has urged governments worldwide to ban cigarette filters because they provide no protection from the risks of smoking and are an environmental pollutant.[34] However, no local, state, provincial, or national government has banned sales of commercial filtered cigarettes. Lack of information among policymakers and the public about the health and environmental impacts of cigarette filters likely impedes such policy actions.

While many people mistakenly believe that smoking a cigarette with a filter is safer than smoking a cigarette without a filter,[4,35,36] little is known about beliefs and attitudes regarding a ban on filtered cigarette sales among people who smoke (and would be most impacted by such a policy). Population-level studies in Aotearoa New Zealand (ANZ)[37] and the United States (US)[38] found that about half of adults supported banning the sale of cigarettes with filters. The ANZ study found that opposition to a filter ban was higher among adults who smoke than among those who do not.[37] The US study found that respondents who believed filters do not make cigarettes less harmful were more likely to support banning filters.[38]

In this multi-country study, we have expanded on previous research to examine whether adults who smoke would oppose banning sales of filtered cigarettes, particularly if they believe that removing filters would increase the harmfulness of cigarettes. We also aimed to identify correlates of both outcomes, including sociodemographic factors, country of residence, smoking frequency, and the type of cigarettes smoked (commercial factory-made cigarettes versus roll-your-own [RYO]). As people who smoke RYO cigarettes construct their cigarettes either with or without a filter (filter accessories are purchased separately), they may differ from those who smoke manufactured cigarettes regarding perceptions of harms and support or opposition for banning cigarette filters.

Methods

Study design, procedure, and population

The International Tobacco Control Smoking and Vaping (ITC 4CV) Survey is a cohort study conducted in Canada, the US, England, and Australia. Eligible respondents were adults (≥18 years) who (1) currently smoke cigarettes at least monthly; (2) recently quit smoking (smoked at least monthly previously, quit in the past 24 months); or (3) use other non-combusted nicotine products at least weekly (e-cigarettes, heated tobacco products, snus, nicotine pouches). Respondents could either use a tobacco/nicotine product exclusively or concurrently (e.g., smoke and vape). All respondents were recruited from online commercial panels using varied probability and non-probability-based sampling methods. All panelists who submitted a valid survey in each wave were invited to participate in the subsequent wave. Respondents lost to follow-up were replaced at each wave by new panelists using the same sampling procedures. All data were collected online, and respondents were remunerated for completing the survey.

Further details about the ITC 4CV methods can be found in the Wave 4 (2022) technical report.[39]

Cross-sectional data for this study were from the Wave 4 ITC 4CV Survey (conducted August to December 2022). Eligible participants included adults who smoked factory-made or RYO cigarettes at least monthly and completed the relevant survey questions outlined below. A study flow diagram can be found in **Supplemental Figure 1**.

Ethical considerations

All participants provided informed consent prior to completing the online survey. The survey was approved by research ethics committees in each country prior to participant recruitment.

Measures

Half of all respondents who completed the Wave 4 survey were randomly assigned to a set of questions about support for/opposition to tobacco regulatory policies. This approach reduced the survey length burden. For the current study, we used the following question to assess support for/opposition to banning cigarette filters: "*Would you support or oppose a law that bans filters so that all cigarettes are sold without filters?"* with response options (a) strongly support, (b) support, (c) oppose, (d) strongly oppose, (e) don't know. Responses were first combined into 'support' (a-b); 'oppose'; (c-d); 'I don't know' (e) to estimate prevalence. For the adjusted regression analyses, the outcome response was dichotomized into 'oppose' (c-d) vs. 'other responses' (a-b, e).

The belief that removing cigarette filters would make cigarettes more harmful was assessed with the question: *"Would removing the filter from a cigarette make it more harmful?"* Response options were: (a) much more harmful, (b) a little more harmful, (c) no, (d) I don't know. This variable was used as an independent variable in the analysis that examined correlates associated with opposition to banning filters and was coded as 'much more harmful' (a) vs.

'other responses' (b-d). It was also used as an outcome variable in the initial descriptive analysis (original response options were used) and for the adjusted regression analyses that aimed to identify correlates related to beliefs about harm when filters are removed from cigarettes. responses were dichotomized into 'much more harmful' vs. 'other responses'.

Covariates

Sociodemographic variables: Age group (18-24, 25-39, 40-54, 55+ years), sex at birth (male, female), education (low, moderate, high, not reported), and income (low, moderate, high, not reported). **Supplemental Table 1** describes the categories for education and income.

Cigarette smoking frequency: *"How often do you CURRENTLY smoke ordinary cigarettes (either factory-made/pack or roll-your-own)?"* Smoking status was defined as 'daily' or 'non-daily' (weekly/monthly).

Cigarette type smoked: *"Do you smoke [factory-made/ pack] cigarettes, roll-your-own cigarettes, or both?"* This variable was coded as: 'only/mainly factor-made cigarettes', 'only/mainly RYO cigarettes', or 'about the same of each'.

Respondent type: The larger ITC study is a cohort study, thus a proportion of the respondents who are invited back have completed more than one survey (referred to as the 'cohort' sample). A new sample of adults were recruited at Wave 4 to replenish those lost to attrition at Wave 3 (referred to as the 'replenishment' sample). We accounted for any potential differences between the cohort and replenishment respondents by using 'respondent type' as a control variable.

Data analysis

Unweighted descriptive statistics were used to describe the study sample. All other analyses were conducted on weighted data (national country surveys were used as benchmarks)[39] using SAS Version 9.4. Statistical significance and confidence intervals (CIs) were computed at the 95% confidence level with two-tailed tests.

In the first set of analyses, weighted descriptive statistics were used to assess prevalence of (1) support, opposition, or don't know responses regarding banning cigarette filters, and (2) the belief that removing cigarette filters would make cigarettes much more harmful, a little more harmful, not more harmful, or don't know. Analyses were conducted overall (all respondents) and by country.

In the second set of analyses, two separate adjusted logistic regression models were fitted to identify correlates of (1) opposition to banning cigarette filters (vs. otherwise), and (2) the belief that removing cigarette filters makes them much more harmful (vs. otherwise). We reported the estimated (conditional) marginal means, adjusted odds ratios (aOR), and 95% CIs from each model. All covariates were included in the models. Additionally, the belief that removing filters makes cigarettes much more harmful (vs. otherwise) was also included in (1). Post-hoc analyses were conducted to examine country differences.

Finally, we conducted a sensitivity analysis using the three categories for banning filters (support, don't know vs. oppose) and for perceived harm if filters are removed (a little more harmful, not more harmful, don't know vs. much more harmful). Both models were conducted using multinomial logistic regression analysis. We reported the estimated (conditional) marginal means, aOR and 95% CIs.

Results

Overall, 2,980 respondents provided complete data for both the primary independent and outcome variables and were included in the study (**Table 1**). Three participants had missing data for the type of cigarettes that they usually smoked and were excluded from the adjusted regression analyses.

Prevalence of support/opposition for a cigarette filter ban policy and perceived harmfulness when filters are removed from cigarettes among adults who smoke

Overall, 11.5% of adults who smoke supported banning filters, 69.3% opposed, and 19.1% did not know (main effect for country differences: p=0.001) (**Figure 1**). Support for banning filters was highest in England (17.9%) and lowest in Australia (7.8%), and opposition was highest in the US (71.6%) and lowest in England (64.6%). Ambivalence over banning cigarette filters was highest in the US (20.5%) and lowest in England (17.5%).

-Insert Figure 1-

Figure 2 presents the descriptive results on the belief about harm when filters are removed from cigarettes, overall and by country. Nearly half (45.9%) of adults who smoke across all countries believe that removing filters would make cigarettes much more harmful, 28.6% a little more harmful, 15.3% did not know, and 10.2% did not believe it would make cigarettes more harmful (main effect for country differences: p=0.002). In other words, three-quarters (74.5%) of adults who smoke believe that removing filters makes cigarettes more harmful, and after removing those who did not know, the prevalence of this misperception is 82.0%. The belief that removing filters would make cigarettes much more harmful was highest in England (48.7%) and lowest in Australia (40.7%). The belief that removing filters would not make cigarettes more harmful was highest in Canada (12.3%) and lowest in England (7.9%).

- Insert Figure 2 –

Correlates of opposition to banning cigarette filters (adjusted model)

We found that differences across countries remained significant after adjusting for other variables (p=0.047) (**Table 2**). Compared to England, adults who smoke in Australia (aOR=1.59, 95% CI: 1.10-2.31) and the US (aOR=1.45, 95% CI:1.05-2.00) were significantly more likely to oppose a filter ban. Canada did not differ significantly from any of the countries. The full country post-hoc analysis is presented in **Supplemental Table 2**.

Adults who believed that removing filters would make cigarettes much more harmful (vs. otherwise) were more likely to oppose banning filters (78.5% vs. 62.1%; aOR=2.23, 95% CI: 1.75-2.83). Adults who smoked daily were more likely to oppose banning cigarette filters (p=0.01) and those who were younger (18-24, 25-39, 40-54 vs. 55+) were less likely to oppose banning filters (p<0.001). There were no significant differences by sex, education, income, type of cigarettes smoked (factory-made vs. RYO) or respondent type (all p≥0.05).

- Insert Table 2 -

For the sensitivity analysis (**Supplemental Table 3**), we expanded the outcome to include all three levels and found the results were relatively consistent with the original logistic regression, with some exceptions.

Oppose vs. support: Compared to supporting banning cigarette filters, those who smoked daily (vs. non-daily), were female (vs. male), and resided in Canada, Australia, or the US (vs. England) were significantly more likely to oppose banning cigarette filters than support it. Adults who smoked both factory-made cigarettes and RYO equally or were younger (18-24, 25-39, 45-54 vs. 55+) were significantly less likely to oppose the policy than support it. Although adults

who believed that removing filters makes cigarettes much more harmful and had a higher rate of opposition (79.6% vs. 63.2%), there was no significant difference in the odds of opposing vs. supporting the policy (9.8% vs. 9.9%; aOR=1.27, 95% CI: 0.91-1.78).

Oppose vs. don't know: Compared to those who reported that they did not know whether they would support the policy, adults who believed that removing filters would make cigarettes much more harmful (vs. otherwise) were significantly more likely to oppose banning filters. Those aged 25-39 years (vs. 55+) were significantly less likely to oppose the policy.

Correlates of the belief that cigarettes without a filter are much more harmful (adjusted model)

The adjusted regression analysis identified correlates of beliefs that removing filters would make cigarettes much more harmful (vs. otherwise) are reported in **Table 3**. After adjustment, there was no longer a statistically significant main effect by country (p=0.18). A full country post-hoc analysis is presented in **Supplemental Table 3**.

Other correlates found to be associated with believing that removing filters makes cigarettes much more harmful were sex (females were more likely to believe this than males, p=0.01) and smoking status (adults who smoked daily were more likely to believe this than adults who smoked non-daily, p=0.03).

– Insert Table 3 –

For the sensitivity analysis (**Supplemental Table 3**), when the outcome was expanded to include all four levels, the results were largely consistent with the original logistic regression, with the exception of country (which was now significant). Adults in Canada (vs. England) were significantly less likely to believe that removing filters makes cigarettes much less harmful vs. not more harmful. Respondents in Australia, Canada and the US (vs. England) were less likely to report that removing filters makes cigarettes much more harmful vs. don't know. Of the

covariates, sex and smoking frequency were still found to be significant. Those who smoked daily (vs. non-daily) or were female (vs. male) were more likely to believe that removing the filter would make cigarettes much more harmful vs. a little more harmful. Females were also more likely to believe that removing the filter would make cigarettes much more harmful vs. not more harmful. No other statistically significant differences were found.

Discussion

This multi-country study of adults who smoke cigarettes evaluated opposition to banning the sale of cigarettes with filters, beliefs about whether removing filters makes cigarettes much more harmful, and whether this belief is associated with opposition to banning filters. We found that across all four countries seven in ten adults who smoked opposed banning filters. About one in four adults were uncertain whether they would support a filter ban or not, and one in ten supported a ban. Notably, we found that almost half of adults who currently smoke believe that removing filters would make cigarettes much more harmful and 30% believe cigarettes would be a little more harmful. Thus, the misperception that filters reduce the harms of cigarettes continues to persist, with three-quarters of respondents (and 82%, if removing those responding "don't know") holding this erroneous belief. Moreover, unsurprisingly, opposition to banning filters (compared to uncertainty or support) was highly associated with the misperception that filters substantially reduce the harmfulness of cigarettes, which has also been previously found among adults in the US general population.[38]

Opposition to banning the sale of cigarettes with filters was higher in our study (ranging from 64.6% in England to 71.6% in the US) than in earlier studies (around half in the US general population[38] and 37% in ANZ among adults who smoke[37]). One potential reason for this could be sample differences because, unlike the US and A/NZ studies, our sample comprised mostly of people who smoke daily (84%) and who smoke factory-made cigarettes (76%).

After adjusting for covariates in the regression model, we found that the US and Australia had the highest rates of opposition to banning the sale of cigarettes with filters (73% and 75% respectively), England the lowest (65%), with Canada in-between (70%). This finding may reflect differences in nicotine policies in each of the countries. Although all four countries have strong national or subnational tobacco control policies, they have different approaches to nicotine product regulation. For example, England has a more supportive framework for tobacco harm reduction (e.g., national health guidelines recommend advising adults who smoke on how to use nicotine vaping products);[40,41] however, the US[42] and Australia[43] have more restrictive policies and less supportive health messaging about the role e-cigarettes may play for quitting smoking. Health Canada regulates e-cigarettes and has stated that "switching completely to vaping means stopping smoking all cigarettes, which will reduce the risks of harms to your health",[44] but e-cigarettes are not supported in clinical practice guidelines for smoking cessation. On further examination, we found that adults who smoke in England had the highest proportion of adults who also vape e-cigarettes (28%, data not shown) compared to Canada (18%), the US (16%), and Australia (13%). Adults who use e-cigarettes may be less concerned about no longer having access to filter-tip cigarettes if they have an alternative nicotine product (other than unfiltered cigarettes) to replace filter-tip cigarettes. This possible explanation warrants further investigation.

We anticipated that adults who mainly/only smoke factory-made cigarettes would have been more strongly opposed to a cigarette filter ban policy than those who smoked RYO, as the cigarette design for factory-made cigarettes would be drastically altered; however, our results did not support this hypothesis. We are uncertain why we found similar rates of both support and opposition, and suggest further investigation of this question. In our sensitivity analyses, we found that people who smoke RYO and factory-made cigarettes equally, were more likely to support a filter ban. Moreover, adults who smoked RYO and factory-made cigarettes were more likely to believe that removing filters would not

make cigarettes more harmful (vs. much more harmful) (17%) than those who only smoked factory-made cigarettes or RYO (both 10%), which may partially explain their higher support.

For decades, tobacco companies have used marketing strategies to deceive consumers about the true harmfulness of cigarettes. Some strategies are cognitive and conceptual, some are sensory, but all are intended to increase the appeal of smoking.[45] These strategies include product packaging, cigarette stick and filter designs (e.g., ventilated filters, activated charcoal filters, flavoured "crush" capsules, colours), brand names and descriptors, and use of additives such as sugars and menthol flavouring to alter the sensory experience of smoking. It is noteworthy that early brands of cigarettes with filters made explicit health claims, leading many consumers to believe that adding a filter to a cigarette would provide health benefits. Our findings confirm that this misperception is very prevalent, with three-quarters of adults who smoke believing that removing a filter would increase harm. Notably, we found that women were more likely to hold this belief compared to men, which may reflect sustained industry marketing of filtered cigarettes to women (including brands with flavor capsules) that presents filters as harm-reducing and offering a smoother, better tasting, and milder smoking experience.[36,46-51] Adults who smoked daily were significantly more likely to believe that filters are harm reducing compared to adults who smoked non-daily. Banning the sale of filtered cigarettes may have greater effects on women [52] and people who smoke more frequently (and who likely have greater dependence on nicotine) by preventing uptake and encouraging quitting smoking.

Cigarette filters have been, and continue to be, part of the fraud that has sustained the tobacco epidemic; it is now time to enact policies to address this. Strong public education campaigns and information on packaging/inserts presenting cigarette filters as fraudulent accessories that do not reduce health harms, but rather increase the risks of lung adenocarcinoma[19-23] and damage the environment[53,54] could increase public support for policies that would disallow filters altogether. However, the strong opposition to banning filters from cigarettes may also reflect perceived lower acceptability and palatability of unfiltered cigarettes.

This study has some limitations. First, the survey question on harm perceptions of removing filters preceded the question on support/opposition to banning cigarette filters. Thus, some order-effects bias may have occurred and respondents may have been primed to (a) use their response about filter harms when answering the policy support question, and (b) answer the question about support or opposition based on their beliefs about the harmfulness of filters (or lack of filters) to humans, rather than for other reasons. For example, support for the policy may have been because filters are harmful to the environment, or banning filters may help encourage people to quit by reducing the positive sensory effects that filters produce. In contrast, opposition may have been because banning filters would make cigarettes less appealing. Second, we did not ask respondents who smoke RYO cigarettes if they usually add a filter or not. We also did not have a question in the survey to determine whether people smoke factory-made cigarettes without filters, although this is likely a small proportion of the sample. Support for banning cigarette filters and beliefs about whether removing filters makes cigarettes much more harmful may vary between people who smoke cigarettes with filters and those who do not, which requires further investigation.

Conclusions: The misperception that removing filters makes cigarette more harmful is widespread. Across all four countries in this study, seven in ten adults who smoke oppose banning filters, which was strongly associated with the misperception that filters substantially reduce harm, which is held by three-quarters of people who smoke. Communication of accurate information about cigarette filters is necessary to address these misperceptions.

Ethics: The ITC Four Country Smoking and Vaping (Australia, Canada, England, and United States) survey protocols and all materials, including the survey questionnaires, were cleared for ethics by Research Ethics Board, University of Waterloo, Canada (REB#20803/30570, REB#20803/30878), Research Ethics and Integrity Committee, The University of Queensland, Australia (IRB 2022/HE001187), Research Ethics Office, King's College London, UK (IRB RESCM-17/18-2240), and ethics clearance at the Medical University of South Carolina, US was waived due to minimal risk.

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Competing interests: KMC has in the past and continues to serve as a paid witness in litigation filed against cigarette manufacturers. GTF has served as an expert witness or consultant for governments defending their country's policies or regulations in litigation. Although JH does not consider it a conflict, she notes that she is a Co-Director of ASPIRE Aotearoa, a University of Otago Research Centre working to achieve the Aotearoa New Zealand Government's Smokefree 2025 goal.

Data Availability Statement: In each country participating in the international Tobacco Control Policy Evaluation (ITC) Project, the data are jointly owned by the lead researcher(s) in that country and the ITC Project at the University of Waterloo. Data from the ITC Project are available to approved researchers 2 years after the date of issuance of cleaned data sets by the ITC Data Management Centre. Researchers interested in using ITC data are required to apply for approval by submitting an International Tobacco Control Data Repository (ITCDR) request application and subsequently to sign an ITCDR Data Usage Agreement. The criteria for data usage approval and the contents of the Data Usage Agreement are described online (http://www.itcproject.org).

Table 1. Respondents' sample characteristics in the current study

	Canada n=787		United States n=678		England n=957		Australia n=558		Overall N=2,980	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Respondent type										
Cohort	497	63.2	379	55.9	372	38.9	241	43.2	1489	50.0
Replenishment	290	36.9	299	44.1	585	61.1	317	56.8	1491	50.0
Smoking frequency										
Daily	624	79.3	577	85.1	804	84.0	509	91.2	2514	84.4
Non-daily	163	20.7	101	14.9	153	16.0	49	8.8	466	15.6
Cigarette type smoked*										
Factory-made cigarettes	721	91.6	608	89.9	589	61.6	355	63.7	2273	76.4
Both equally	46	5.8	20	3.0	91	9.5	35	6.3	192	6.5
RYO cigarettes	20	2.5	48	7.1	277	28.9	167	30.0	512	17.2
Age group (years)										
18-24	114	14.5	27	4.0	64	6.7	20	3.6	225	7.6
25-39	162	20.6	150	22.1	248	25.9	118	21.2	678	22.8
40-54	273	34.7	189	27.9	300	31.4	209	37.5	971	32.6
55+	238	21.5	312	46.0	345	36.1	211	37.8	1106	37.1
Sex (at birth)										
Male	397	50.4	327	48.2	476	49.7	291	52.2	1491	50.0
Female	390	26.4	351	51.8	481	50.3	267	47.9	1489	50.0
Annual household income										
Low	184	23.4	251	37.0	187	19.5	128	22.9	750	25.2
Moderate	239	30.4	175	25.8	273	28.5	110	19.7	797	26.7
High	324	41.2	250	36.9	434	45.4	282	50.5	1290	43.3
Not reported	40	5.1	2	0.3	63	6.6	38	6.8	143	4.8
Education (highest level)										
Low	206	26.2	269	39.7	118	12.3	153	27.4	746	25.0
Moderate	345	43.8	276	40.7	468	48.9	238	42.7	1327	44.5
High	232	29.5	133	19.6	357	37.3	158	28.3	880	29.5
Not reported	4	0.5	0	0.0	14	1.5	9	1.6	27	0.9

Data are unweighted and unadjusted. RYO; Roll-your-own. *Three respondents declined to answer what type of cigarettes they smoke (n=2,977).

Table 2. Model 1: Adjusted regression analysis identifying factors associated with opposition to a cigarette filter ban among adults who smoked in 2022.

	Opposed to banning cigarette filters Weighted % (95% CI)	p-value*	aOR	95% CI
Perceived harm if filter is removed		<0.001		
Much more harmful	78.5 (75.1-81.5)		2.23	1.75 - 2.83
Other response	62.1 (58.7-65.4)		Ref	
Country		0.047		
Australia	74.9 (68.8-80.2)		1.59	1.10 - 2.31
Canada	70.0 (65.0-74.5)		1.24	0.89 - 1.72
United States	73.1 (68.6-77.2)		1.45	1.05 - 2.00
England	65.3 (60.0-70.2)		Ref	
Smoking frequency		0.01		
Daily	71.5 (68.9-74.0)		1.62	1.14 - 2.28
Non-daily	60.8 (53.2-67.9)		Ref	
Cigarette type smoked		0.063		
Factory-made	71.6 (68.8-74.3)		1.20	0.86 - 1.67
Both factory-made and roll-your-own	57.5 (44.6-69.5)		0.64	0.35 - 1.17
Roll-your-own	67.8 (61.2-73.8)		Ref	
Age group (years)		<0.001		
18-24	66.2 (55.4-75.5)		0.59	0.36 - 0.96
25-39	63.0 (57.0-68.6)		0.51	0.37 - 0.69
40-54	71.1 (67.4-74.5)		0.74	0.57 - 0.94
55+	77.0 (73.7-80.0)		Ref	
Sex		0.26		
Female	71.7 (68.3-74.9)		1.14	0.91 - 1.44
Male	68.9 (65.4-72.2)		Ref	
Annual household income		0.46		
Low	69.5 (64.7-74.0)		1.01	0.76 - 1.36
Moderate	70.3 (65.5-74.6)		1.05	0.78 - 1.40
Not reported	78.7 (67.6-86.7)		1.64	0.89 - 3.00
High	69.3 (65.1-73.1)		Ref	
Education (highest level)		0.23		
Low	68.4 (63.5-72.9)		0.94	0.66 - 1.32
Moderate	72.3 (68.9-75.5)		1.13	0.83 - 1.54
Not reported	53.2 (30.2-74.9)		0.49	0.18 - 1.34
High	69.8 (64.1-74.9)		Ref	
Respondent type		0.24		
Cohort	71.7 (68.3-74.8)		1.15	0.91 - 1.46
Replenishment	68.7 (65.0-72.2)		Ref	

Model 1. N=2,977 (3 respondents did not report on the type of cigarettes they smoked). aOR: Adjusted odds ratio. Ref: Reference. CI: Confidence interval. The reference for the outcome variable was 'other response': support for a filter ban or don't know whether they support or oppose a filter ban. *P-value is the omnibus test (main effect) in the adjusted model.

Table 3. Model 2: Adjusted regression analysis that examined factors associated with the belief that removing cigarette filters makes cigarettes much more harmful

	Removing filters would make cigarettes much more harmful Weighted % (95% CI)	p-value*	aOR	95% CI
Country		0.18		
Australia	41.5 (35.2 - 48.0)		0.72	0.52 - 1.00
Canada	43.7 (38.8 - 48.8)		0.78	0.59 - 1.05
United States	45.1 (40.6 - 49.7)		0.83	0.63 - 1.10
England	49.8 (44.8 - 54.7)		Ref	
Smoking frequency		0.03		
Daily	46.6 (43.8 - 49.4)		1.42	1.03 - 1.94
Non-daily	38.1 (31.6 - 45.1)		Ref	
Cigarette type smoked		0.08		
Factory-made	47.3 (44.3 - 50.3)		1.28	0.95 - 1.72
Both factory-made and roll-your-own	36.4 (26.0 - 48.2)		0.82	0.47 - 1.43
Roll-your-own	41.2 (35.0 - 47.7)		Ref	
Age group (years)		0.84		
18-24	50.0 (39.3 - 60.8)		1.22	0.77 - 1.94
25-39	44.4 (38.7 - 50.3)		0.97	0.73 - 1.29
40-54	45.7 (41.8 - 49.7)		1.03	0.83 - 1.27
55+	45.1 (41.5 - 48.8)		Ref	
Sex		0.004		
Female	49.6 (46.1 - 53.1)		1.36	1.10 - 1.66
Male	42.1 (38.5 - 45.7)		Ref	
Annual household income		0.77		
Low	44.5 (39.7 - 49.3)		1.06	0.78 - 1.43
Moderate	44.2 (39.4 - 49.1)		1.14	0.87 - 1.49
Not reported	44.5 (33.1 - 56.5)		1.06	0.39 - 2.92
High	47.3 (43.2 - 51.4)		Ref	

Education (highest level)		0.80		
Low	44.9 (40.2 - 49.7)		0.89	0.69 - 1.16
Moderate	46.8 (43.2 - 50.5)		0.88	0.68 - 1.15
Not reported	45.1 (23.6 - 68.7)		0.89	0.53 - 1.49
High	43.6 (38.2 - 49.1)		Ref	
Respondent type		0.26		
Cohort	47.0 (43.5 - 50.5)		1.13	0.92 - 1.39
Replenishment	44.0 (40.3 - 47.8)		Ref	

Model 2. N=2,977 (3 respondents did not report on the type of cigarettes they smoked). aOR: Adjusted odds ratio. Ref: Reference. CI: Confidence interval. The reference for the outcome variable was 'other response': removing filters from cigarettes would make them a little more harmful/not more harmful/don't know). *P-value is the omnibus test in the adjusted model.

References

1. Doll R, Hill AB. The mortality of doctors in relation to their smoking habits; a preliminary report. *British Medical Journal*. 1954;1(4877):1451-1455.

2. Doll R, Hill AB. Lung cancer and other causes of death in relation to smoking; a second report on the mortality of British doctors. *British Medical Journal*. 1956; 2(5001):1071-1081.

3. Evans-Reeves K, Lauber K, Hiscock R. The 'filter fraud' persists: the tobacco industry is still using filters to suggest lower health risks while destroying the environment. *Tob Control*. 2022;31(e1):e80-e82.

4. Tobacco Tactics. Cigarette filters. University of Bath. 2023. https://tobaccotactics.org/article/cigarette-filters/#:~:text=Filters%20were%20initially%20used%20from,in%20the%20USA%20in%201931. Accessed October 1, 2024.

5. University of California, San Francisco (UCSF). Industry documents library. Meeting, 9 A.M., November 5, 1953, Sloan-Kettering Institute. https://www.industrydocuments.ucsf.edu/docs/#id=grcp0140. Accessed October 1, 2024.

6. U.S. Department of Health, Education, and Welfare. *Smoking and Health: Report of the Advisory Committee to the Surgeon General of the Public Health Service*. Washington: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control,1964.

7. Pauly JL, Mepani AB, Lesses JD, Cummings KM, Streck RJ. Cigarettes with defective filters marketed for 40 years: what Philip Morris never told smokers. *Tob Control.* 2002;11(Suppl 1):I51–I61.

8. University of California, San Francisco (UCSF). False and misleading advertising (filtertip cigarettes) twentieth report by the Committee on Government Operations. United States Government Printing Office; 1958. https://www.industrydocuments.ucsf.edu/tobacco/docs/#id=lrbd0124. Accessed October 1, 2024.

9. Harris B. The intractable cigarette 'filter problem'. *Tob Control*. 2011;20 Suppl 1(Suppl_1):i10-i16.

10. U.S. Congress. False and Misleading Advertising (FilterTip Cigarettes): Hearings Before a Subcommittee of the Committee on Government Operations, House of Representatives, 85th Congress, 1st Session 1957, p. 147.

11. Federal Trade Commission. *Cigarette Report for 2021.* Federal Trade Commission; 2023. https://www.ftc.gov/system/files/ftc_gov/pdf/p114508cigarettereport2021.pdf. Accessed October 1, 2024.

12. Cummings KM, Roberson A, Carroll DM, et al. Illusion of filtration: Evidence from tobacco industry documents. *Tob Induc Dis*. 2023; 21:85.

13. Kozlowski LT, O'Connor RJ. Cigarette filter ventilation is a defective design because of misleading taste, bigger puffs, and blocked vents. *Tob Control*. 2002;11:i40–50.

14. Shiffman S, Pillitteri JL, Burton SL, Rohay JM, Gitchell JG. Smokers' beliefs about "light" and "ultra light" cigarettes. *Tob Control*; 2001;1:i17–23.

15. Winnall WR, Scollo MM. *Construction of cigarettes and cigarette filters*. In Greenhalgh EM Scollo MM, Winstanley MH [editors]. Tobacco in Australia: Facts and issues. Melbourne: Cancer Council Victoria. 2022. https://www.tobaccoinaustralia.org.au/chapter-12-tobacco-products/12-8-construction-of-cigarettes-and-cigarette-filters. Accessed October 1, 2024.

16. Talhout R, Richter PA, Stepanov I, Watson CV, Watson CH. Cigarette design features: effects on emission levels, user perception, and behavior. *Tob Regul Sci*. 2018;4:592–604.

17. Cummings KM, Brown A, Philipson B. *History of the evolution of tobacco products*. In: Hecht SS, Hatsukami DK, eds. Tobacco and Cancer: The Science and the Story. World Scientific Publishing Co. Pte. Ltd; 2022.

18. Thun MJ, Carter BD, Feskanich D, et al. 50-year trends in smoking-related mortality in the United States. *N Engl J Med.* 2013;368(4):351-364

19. US Department of Health and Human Services. *The Health Consequences of Smoking–50 Years of Progress: A Report of the Surgeon General*. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014.

20. Horn L. Pulmonary Adenocarcinoma: Approaches to Treatment. Elsevier Inc.; 2019.

21. Song MA, Benowitz NL, Berman M, et al. Cigarette Filter Ventilation and its Relationship to Increasing Rates of Lung Adenocarcinoma. *J Natl Cancer Inst*. 2017;109(12):djx075.

22. Stellman SD, Muscat JE, Thompson S, Hoffmann D, Wynder EL. Risk of squamous cell carcinoma and adenocarcinoma of the lung in relation to lifetime filter cigarette smoking. *Cancer*. 1997;80(3):382–388.

23. Charloux A, Quoix E, Wolkove N, Small D, Pauli G, Kreisman H. The increasing incidence of lung adenocarcinoma: reality or artefact? A review of the epidemiology of lung adenocarcinoma. *Int J Epidemiol*. 1997;26(1):14-23.

24. Browne CL. *The design of cigarettes.* 3rd ed. Charlotte, N.C.: Hoechst Celanese; 1990.

25. Proctor RN. *Golden Holocaust: Origins of the Cigarette Catastrophe and the Case for Abolition.* University of California Press; 2011.

26. National Cancer Institute. *Tobacco Control Monograph No. 13.* U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute; 2001. Risks Associated with Smoking Cigarettes with Low Machine-Measured Yields of Tar and Nicotine (Chapter 13). https://cancercontrol.cancer.gov/sites/default/files/2020-06/m13_complete.pdf

27. Pauly JL, Allaart HA, Rodriguez MI, Streck RJ. Fibers released from cigarette filters: an additional health risk to the smoker? Cancer Res. 15;55(2):253-258.

28. Baeza-Martinez C, Ruiz-Alcaraz S, Soler-Sempere MJ, Garcia-Pachon E, Hernandez-Blasco L, Bayo J. Tobacco as a Source of Microplastics and Respiratory Health. *Arch Bronconeumol*. 2022;58(12):845.

29. Robert K. *Tobacco Smoke*, *Encyclopedia of Toxicology*, vol. 4 (2nd ed.), Elsevier; 2005: 200-202.

30. Hoffmann D, Rivenson A, Hecht SS. The biological significance of tobacco-specific N-nitrosamines: smoking and adenocarcinoma of the lung. *Crit Rev Toxicol*. 1996;26(2):199-211.

31. Wynder EL, Muscat JE. The changing epidemiology of smoking and lung cancer histology. *Environ Health Perspect*. 1995;103 Suppl 8(Suppl 8):143-148.

32. Slaughter E, Gersberg RM, Watanabe K, Rudolph J, Stransky C, Novotny TE. Toxicity of cigarette butts, and their chemical components, to marine and freshwater fish. *Tob Control*. 2011;20(Suppl 1):i25-i29.

33. Dobaradaran S, Soleimani F, Akhbarizadeh R, Schmidt TC, Marzban M, BasirianJahromi R. Environmental fate of cigarette butts and their toxicity in aquatic organisms: A comprehensive systematic review. *Environ Res*. 2021;195:110881.

34. World Health Organization. WHO raises alarm on tobacco industry environmental impact; 2022. https://www.who.int/news/item/31-05-2022-who-raises-alarm-on-tobacco-industry-environmental-impact. Accessed October 1, 2024).

35. Truth Initiative [internet]. Cigarette filters mislead consumers, with 1 in 3 smokers falsely believing filters reduce harm. 2021. https://truthinitiative.org/research-resources/harmful-effects-tobacco/cigarette-filters-mislead-consumers-1-3-smokers-falsely (accessed 10 June 2024).

36. O'Connor RJ, Bansal-Travers M, Cummings KM, Hammond D, Thrasher JF, Tworek C. Filter presence and tipping paper color influence consumer perceptions of cigarettes. *BMC Public Health*. 2015;15:1279.

37. Hoek J, Gendall P, Blank ML, Robertson L, Marsh L. Butting out: an analysis of support for measures to address tobacco product waste. *Tob Control*. 2019;tobaccocontrol-2019-054956.

38. Patel M, Cuccia AF, Folger S, Benson AF, Vallone D, Novotny TE. Support for cigarette filter waste policies among US adults. *Tob Control*. 2023;32(1):118-20.

39. ITC Project. (2024, October). ITC Four Country Smoking and Vaping Survey, Wave 4 (4CV4, 2022) Technical Report. University of Waterloo, Waterloo, Ontario, Canada; Medical University of South Carolina, Charleston, South Carolina, United States; the University of Queensland, Australia; King's College London, London, United Kingdom. https://itcproject.s3.amazonaws.com/uploads/documents/4CV4_Technical_Report_1Oct2024.pdf Accessed October 2, 2024).

40. National Institute for Health and Care Excellence (NICE). Tobacco: preventing uptake, promoting quitting and treating dependence. NICE guideline [NG209]; 2021. https://www.nice.org.uk/guidance/ng209 Accessed October 2, 2024.

41. National Health Service (NHS). Using e-cigarettes to stop smoking; 2022. https://www.nhs.uk/live-well/quit-smoking/using-e-cigarettes-to-stop-smoking/ Accessed October 2, 2024.

42. US Food and Drug Administration (FDA). Facts about E-Cigarettes; 2023. https://www.fda.gov/news-events/rumor-control/facts-about-e-cigarettes Accessed October 2, 2024.

43. Australian Government. Department of Health and Aged Care. About vaping and e-cigarettes. https://www.health.gov.au/topics/smoking-vaping-and-tobacco/about-vaping#:~:text=On%201%20July%202024%2C%20the,disposable%20vapes%20in%20a%20pharmacy. Accessed October 2, 2024.

44. Government of Canada. Vaping and quitting smoking. Ottawa (ON) Health Canada; 2023. https://www.canada.ca/en/health-canada/services/smoking-tobacco/vaping/quit-smoking.html Accessed October 2, 2024.

45. National Cancer Institute (NCI). *The Role of the Media in Promoting and Reducing Tobacco Use. Tobacco Control Monograph No. 19*. Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute. NIH Pub. No. 07-6242. 2008. https://cancercontrol.cancer.gov/brp/tcrb/monographs/monograph-19 Accessed October 2, 2024.

46. Johnston ME/Philip Morris, Market potential of a health cigarette: Special report no. 248, 16, Truth Tobacco Documents Library, Bates No. 1000338663; 1966.

47. Thrasher JF, Abad-Vivero EN, Moodie C, et al. Cigarette brands with flavour capsules in the filter: trends in use and brand perceptions among smokers in the USA, Mexico and Australia, 2012-2014. *Tob Control*. 2016;25(3):275-283.

48. Tinkler P. "Red tips for hot lips": advertising cigarettes for young women in Britain, 1920-70. Womens Hist Rev. 2001;10(2):249-72.

49. Pollay RW, Dewhirst T. *Marketing Cigarettes with Low Machine-Measured Yields*. In National Cancer Institute. Risks Associated with Smoking Cigarettes with Low Machine-Measured Yields of Tar and Nicotine. Tobacco Control Monograph No. 13. Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute. NIH Pub. No. 02-5047, October 2001. https://cancercontrol.cancer.gov/sites/default/files/2020-08/m13_complete.pdf Accessed October 2, 2024.

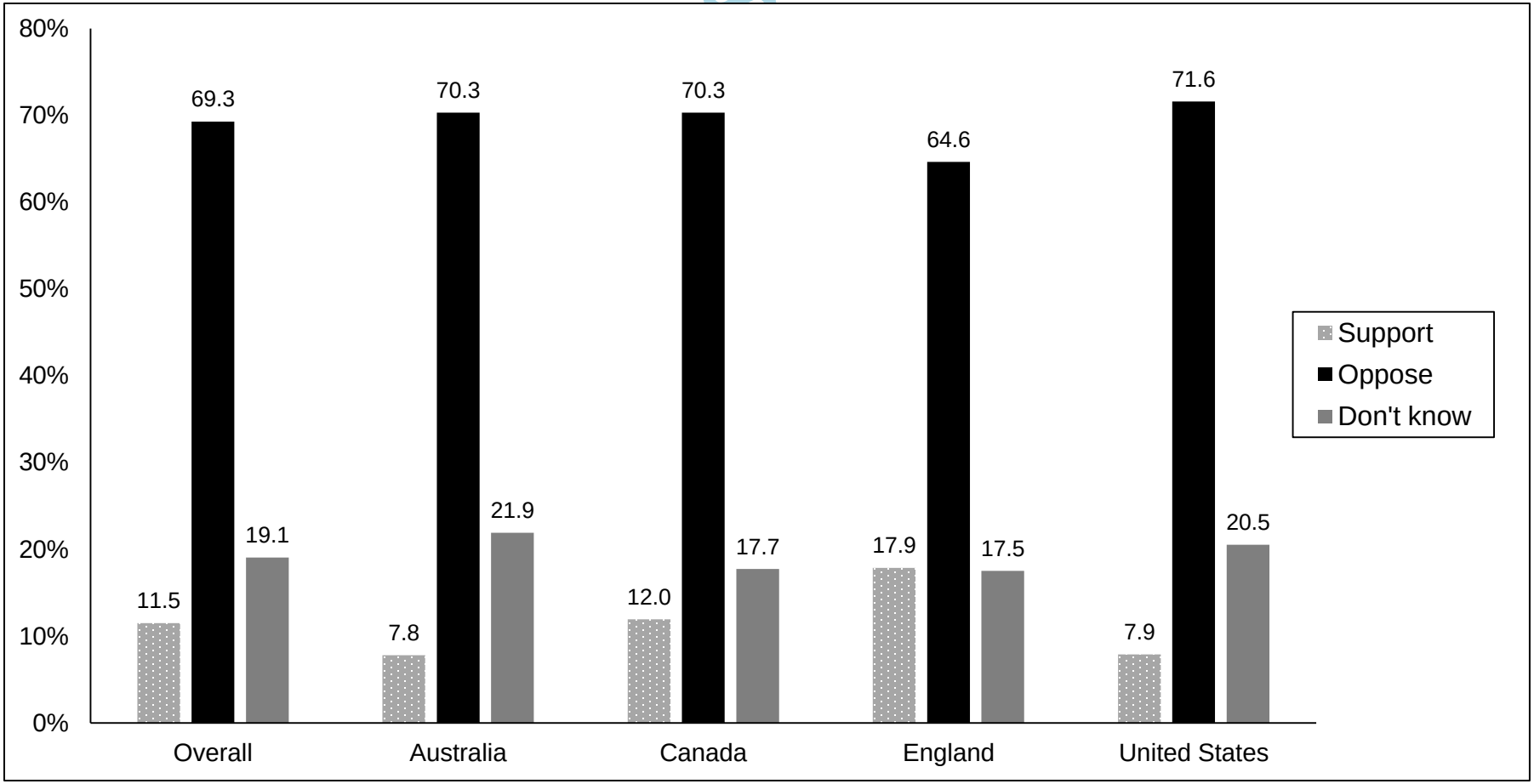
50. Carpenter CM, Wayne GF, Connolly GN. Designing cigarettes for women: new findings from the tobacco industry documents. *Addiction*. 2005;100(6):837-851.

51. Moodie C, Ford A, Mackintosh A, Purves R. Are all cigarettes just the same? Female's perceptions of slim, coloured, aromatized and capsule cigarettes. *Health Educ Res*. 2015;30(1):1-12.

52. Yale School of Medicine. The Importance of Considering Sex and Gender in Tobacco Regulation. 2023. https://medicine.yale.edu/news-article/the-importance-of-considering-sex-and-gender-in-tobacco-regulation/ Accessed October 2, 2024.

53. Tabbakh T, Mitsopoulos E, Nuss T, Durkin SJ. Messages about climate, pollution and social justice harms of tobacco as motivators to quit: an untapped communication opportunity? *Tob Control*. 2024;tc-2023-058161.

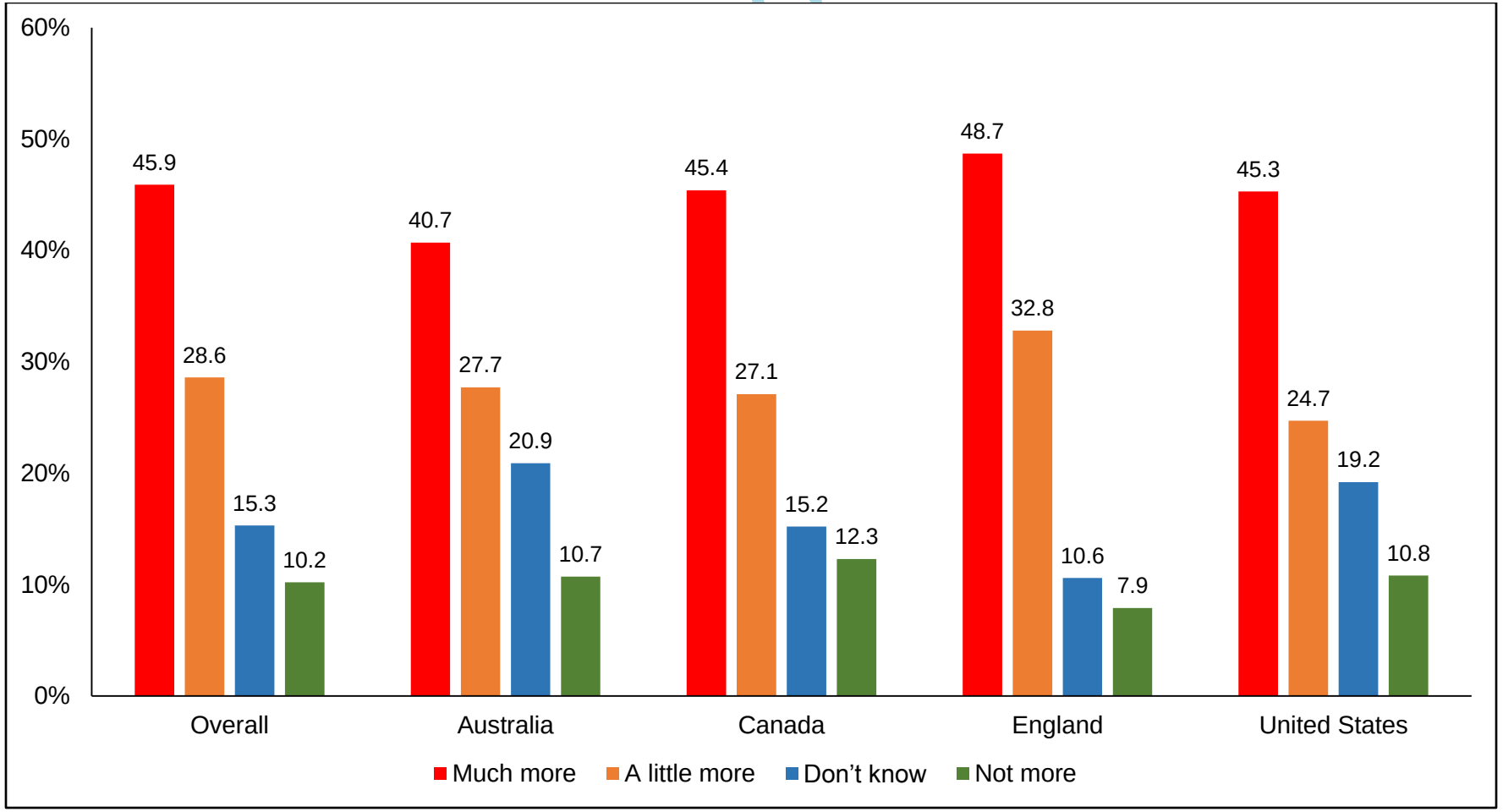
54. Morphett K, Hyland A, Sellars D, Gartner C. The environmental impact of tobacco products: Time to increase awareness and action. *Addiction*. 2023;118(3):396-398.



N=2,890. Data are weighted and unadjusted. Wald=3.8, p<0.001.

Figure 1. Prevalence of support, opposition, or uncertainty toward a law banning the sale of cigarettes with filters in Australia, Canada, England, and the United States in 2022 among adults who smoke at least monthly.

Alt text: Support, opposition, or uncertainty toward banning filter-tip cigarettes among adults who smoke in four-high-income countries.



N=2,890. Data are weighted an unadjusted. Wald=2.96, p=0.002.

Figure 2. Prevalence of the belief that removing filters makes cigarettes much more harmful, a little more harmful, not more harmful, or don't know among adults who smoke at least monthly in Australia, Canada, England, and the United States in 2022.

Alt Text: Adults who smoked in four high-income countries and their beliefs as to whether removing filters makes cigarettes much more harmful, a little more harmful, not more harmful, or do not know.