Awareness of alcohol as a risk factor for cancer: A population-based cross-sectional study among 3000 Danish men and women

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ABSTRACT

Alcohol increases the risk of several cancer types. However, awareness of the link between alcohol and cancer is estimated to be low in Denmark. The objective of this study was to examine awareness of alcohol as a risk factor for cancer in the Danish population. 3000 Danish men and women aged 18–74 years, who are nationally representative participated in a cross-sectional study. Open and closed-ended questions were used to assess unprompted and prompted cancer awareness in relation to the respondents' demographic profile, alcohol consumption and use of tobacco.

Unprompted, 22.2% of respondents were aware of the link between alcohol and cancer, whereas prompted 44.8% were aware of this. When prompted about specific cancer types, 39.5% were aware of the fact that alcohol increases the risk of liver cancer and only 9.6% were aware of the link between alcohol and breast cancer. Being aware of the link between alcohol and cancer was associated with being female, having a higher level of education, living in the Capital Region of Denmark, as well as being a non-smoker. There were no statistical significant associations between awareness of alcohol as a risk factor for cancer and the respondents' age, marital status and alcohol consumption.

Conclusively, the study confirms a rather low public awareness of the link between alcohol and cancer in the Danish population, especially regarding certain cancer types such as breast cancer. There is a continued need to inform the public about the relationship between alcohol and cancer.

1. Background

Since 1988, alcohol has been classified as a group 1 carcinogen by the International Agency for Research into Cancer (International Agency for Research on Cancer, 1988). There is convincing evidence that alcohol increases the risk of cancer in the mouth, pharynx, larynx, esophagus, liver, breast and colorectal (International Agency for Research on Cancer, 2010; Bagnardi et al., 2015). The risk of developing cancer increases with alcohol intake (International Agency for Research on Cancer, 2010). Worldwide, it is estimated that 4% of all cancer incidence can be attributed to alcohol intake (WHO, 2018), and in Denmark it is estimated that 5% of all cancer incidence are attributed to alcohol intake (Schütze et al., 2011). National estimates show high level of alcohol consumption among Danes with an annually consumption of 9.1 L of alcohol per capita aged 15 and over (OECD Data). Furthermore that 18% of the adult Danes consume more than the national recommendations for alcohol intake (weekly limit of max 14 units for men and max 7 units for women – 1 unit ~12 g) (Jensen et al., 2017).

Despite the well-documented association between alcohol and cancer, public awareness of alcohol as a risk factor for cancer is rather low across the world including Denmark (Scheideler and Klein, 2018; Lagerlund et al., 2015; Kippen et al., 2017; Redeker et al., 2009; Sanderson et al., 2009; Coomber et al., 2017; Buykx et al., 2015a, 2015b; Cotter et al., 2013). A study from 2015 found that only 56.7% of Danish adults recognized alcohol as a risk factor for cancer, when they were directly asked if alcohol increases the risk of cancer (prompted awareness) (Lagerlund et al., 2015). Prompted awareness is generally higher than unprompted awareness measured by an open-ended question and awareness seems to differ for different cancer types (Scheideler and Klein, 2018; Buykx et al., 2015). Previous studies from around the world have shown that the awareness of the relationship between alcohol and cancer is especially low among men, people with low levels of education, people living outside metropolitan areas and smokers (Scheideler and Klein, 2018; Sanderson et al., 2009; Buykx et al., 2015). However, no Danish studies have examined unprompted awareness of the link between alcohol and cancer, and the association with demographics and health-related factors.

As the knowledge of the association between alcohol and cancer seem to be low among Danish adults, there is a need and a potential to raise awareness of this link in the population. In Denmark, alcohol prevention has long been on the agenda and there have been many preventive campaigns throughout time. However, the majority of these campaigns has mainly been focusing on drinking less alcohol and not on informing about health-related consequences of alcohol intake, including the association between alcohol and cancer (Sundhedsstyrelsen. Kampagner). Experiences from Denmark and abroad show that it is possible to increase the population's awareness of the link between alcohol and cancer through campaign efforts (Buykx et al., 2015; Christensen et al., 2019; Dixon et al., 2015), and furthermore, an Australian study has found that increased knowledge of the link between alcohol and cancer was associated with lower alcohol intake (Dixon et al., 2015). Thus, there is evidence that targeted campaign efforts can increase awareness of the link between alcohol and cancer, and that this increased awareness may potentially contribute to lowering alcohol consumption.

The aim of this study is to examine Danes' awareness of the link between alcohol and cancer, including how awareness differs by demographic factors, alcohol consumption and between smokers and non-smokers. This knowledge can be useful in order to design and target future campaigns and preventive efforts focusing on alcohol as a risk factor for cancer.

2. Methods

2.1. Study design

Cross-sectional data was collected as a baseline web-based survey prior to a national information campaign focusing on alcohol as a risk factor for cancer from September 4 to October 8, 2017. The study population consisted of 3000 Danish males and females aged 18 to 74 years. Quota sampling was applied to ensure that the sample was nationally representative with respect to age, sex and geographical region as well as education (not within specific quota). In the survey, panel members from the market research company Voxmeter A/S were invited to participate in a web-based survey with written answers without any information of the content or organizations commissioning the survey. Every respondent in the study population received the same questionnaire.

2.2. Study measures

2.2.1. Awareness of the relationship between alcohol and cancer

Unprompted cancer awareness was determined by the open-ended question: "*Which diseases do you think, alcohol increases the risk of? Please state all diseases that come to your mind*". Any mention of cancer, tumor or specific cancer diseases was coded as unprompted awareness. Prompted cancer awareness was determined by asking the respondents the following question: "*Which of the following diseases and conditions do you think alcohol increases the risk for?*". The respondents were presented with a list of seven health conditions in random order: Cancer, heart disease, diabetes, high cholesterol, liver disease, overweight and arthritis. All respondents received this question, independently of their answers in the previous question regarding unprompted cancer awareness. Respondents who had prompted cancer awareness got the following questions: "*Which of the following cancer types do you think alcohol increases the risk of?*". The question was presented by a list of specific cancers in random order including cancers of the breast, esophagus, head and neck, liver, colorectal, and other types of cancer. In the study analysis, only cancer types that are known to be associated with alcohol (breast cancer, esophagus cancer, head and neck cancer, liver cancer and colorectal cancer) are used. In the questionnaire the cancer type 'head and neck' are defined as mouth, pharynx and larynx. For each of these questions, it was also possible to answer "I do not know".

2.2.2. Demographic factors

Demographic factors included in this study were sex (male and female), age (18–29; 30–39; 40–49; 50–59; and 60–74 year), marital status (married; cohabitant; in a relationship; single; and other), education level (primary school; vocational school; upper secondary school; higher education ≤2 year; higher education >2– <5 year; higher education ≥5 year; and other), and geographical region (Capital; Zealand; Southern; Central; North).

2.2.3. Health-related behaviors

Health-related behaviors included in this study were alcohol consumption and use of tobacco. Alcohol consumption was assessed by estimating alcohol intake on every single day during a typical week. The data on alcohol consumption was coded according to the weekly risk limits for alcohol intake for men and women stated by the Danish National Board of Health (below low limit risk: ≤7 for women, ≤14 for men; between low and high limit risk: >7-≤14 for women, >14–≤21 for men; above high limit risk: >14 for women, >21 for men; and don't know). Use of tobacco was assessed by considering the respondents' current smoking behavior (never-smoker; ex-smoker; current smoker; and don't know).

2.2.4. Statistical analysis

Statistical analyses were performed on data for all 3000 respondents. Logistic regression was used to examine the associations between the exposure variables and awareness of the link between alcohol and cancer (unprompted, prompted, and the five specific cancer types). In the analyses, sex, age, marital status, education level, geographical region, alcohol consumption and use of tobacco were considered as potential confounders based on the literature and a priori knowledge. For all analyses, statistical significance was estimated from a 5% significance level and a p-value of < 0.05 was considered statistically significant. All statistical analyses were conducted in STATA 14.0.

3. Results

3.1. Characteristics of study population

The characteristics of the study population are shown in Table 1. Out of the 3000 respondents, 50% were females and the average age was 47.8 years. Nearly half (48.2%) were married while a few were in a relationship but not cohabiting (6.9%). 45.3% had a higher education of minimum 2 years or more and 10.3% only had primary school. One third of the respondents lived in the Capital Region of Denmark (31.8%) while fewest of respondents lived in the Northern Region of Denmark (10.3%). The majority (81.9%) of the respondents had an average weekly alcohol intake below the low risk limit for alcohol intake, 8.3% had an average weekly alcohol intake between low and high limits, and 4.9% of the respondents had a weekly average alcohol intake above the high risk limit for alcohol intake. Just under half (48.4%) of the respondents were never-smokers, while 27.4% were ex-smokers and 23.6% were current smokers (Table 1).

3.2. Unprompted and prompted awareness

As shown in Table 2, 22.2% of the respondents were aware of the link between alcohol and cancer unprompted.

When prompted 44.8% of the respondents were aware of the link between alcohol and cancer. When respondents were presented with specific cancer types, most respondents knew that alcohol increases the risk of liver cancer (39.5%) followed by esophagus cancer (26.1%), colorectal cancer (24.1%) and head and neck cancer (15.4%), whereas fewest respondents knew that alcohol increases the risk of breast cancer

Table 1
Characteristics of the study population (n = 3000) in Denmark in 2017.

	Numbers (n)	Percent %
Total	3000	100.0
Sex	1500	50.0
Male	1500	50.0
Female		
Age (years)		
18–29	654	21.8
30–39	495	16.5
40–49	560	18.7
50–59	566	18.9
60–74	725	24.2
Marital status		
Married	1445	48.2
Cohibitant	524	17.5
In a relationship (not cohibitant)	208	6.9
Single	799	26.6
Other	24	0.8
Educational level		
Primary school	310	10.3
Vocational school	686	22.9
Upper secondary	625	20.8
Higher education < 2 year	440	14.7
Higher education > 2 < 5 year	557	18.6
Higher education > 5 year	359	12
Other	23	0.8
Geographical region		
Capital	955	31.8
Zealand	431	14.4
Southern	629	21
Central	677	22.6
North	308	10.3
Alcohol consumption		
Below low limit risk	2457	81.9
Between low and high limit risk	250	8.3
Above high limit risk	146	4.9
Don't know	147	4.9
Use of tobacco		
Never-smoker	1452	48.4
Ex-smoker	823	27.4
Current smoker	707	23.6
Don't know	18	0.6

(9.6%).

3.3. Characteristics associated with awareness

Table 3 shows the odds for cancer awareness (both unprompted, prompted, and cancer specific) in regard to demographic factors and health-related behaviors.

The following factors were associated with unprompted and prompted cancer awareness: being female (OR = 1.39 [1.16–1.66] for unprompted and 1.46 [1.26–1.70] for prompted; ref. male), having a higher education ≥2 years (OR = 1.61 [1.11–2.33] for unprompted and 1.50 [1.12–2.02] for prompted; ref. primary school) or ≥5 years (OR = 2.33 [1.57–3.45] for unprompted and = 1.85 [1.33–2.56] for prompted; ref. primary school), and being a never-smoker (OR = 0.56 [0.43–0.71] for unprompted and 0.73 [0.60–0.88] for prompted; ref. never-smoker). Furthermore, a statistical significant trend was found in relation to the respondents' increasing education level in regard to both unprompted (adjusted OR = 1.13 [1.07–1.20]) and prompted cancer awareness (adjusted OR = 1.11 [1.06–1.17]) as well as awareness in relation to specific cancer types except for breast cancer (adjusted OR esophagus cancer = 1.14 [1.08–1.20]; head and neck cancer = 1.10 [1.03–1.17]; liver cancer = 1.11 [1.06–1.17]; colorectal cancer = 1.12 [1.06–1.18]) (Results are shown in appendix). No statistically significant associations were found between unprompted and prompted awareness of the link between alcohol and cancer in relation to the respondents' age, marital status, geographical region and alcohol consumption.

As shown in table 3, a statistically significant association between awareness of the link between alcohol and specific cancer types in relation to the respondents' sex and education level was found. For all cancer types, being female and having a higher education of minimum 2 years (except for colorectal and breast cancer) was associated with higher odds for awareness of the link between the cancer types and alcohol compared to being male and only having primary school as the highest education level. Furthermore, we found a statistically significant association between geographical region and awareness of the link between alcohol and breast cancer, esophagus cancer, liver cancer and colorectal cancer with a tendency for the respondents living in the Capital Region of Denmark to be more aware of the fact that alcohol increases the risk for the specific cancer types than respondents living in other regions (Table 3).

4. Discussion

In this study, we found that unprompted, 22.2% of respondents were aware of the link between alcohol and cancer, whereas prompted 44.8% were aware of this. Furthermore, we found that only four out of ten respondents were aware of the fact that alcohol increases the risk of liver cancer (39.5%) and even fewer respondents were aware of the link between alcohol and breast cancer (9.6%). We found, that being female, having a higher level of education, living in the Capital Region of Denmark, and being a never-smoker was associated with being aware of alcohol as a risk factor for cancer.

4.1. Unprompted and prompted awareness

Unprompted and prompted awareness of the link between alcohol and cancer in the study population were low, which is in line with similar studies from around the world, which also indicate a low unprompted and prompted awareness, both in terms of cancer in general and for specific cancer types. A review found that unprompted awareness differ from 2.4% to 24.6% in seven different studies (Scheideler and Klein, 2018). Regarding prompted awareness, the same review found that prompted awareness of the link between alcohol and cancer ranges from 10.1 to 92.2% (Scheideler and Klein, 2018). For instance, Lagerlund et al., a Danish-Swedish study, found that 56.7% of the Danish respondents had prompted awareness of the link between alcohol and cancer (Lagerlund et al., 2015). This indicates that many people are not aware of the association between alcohol and cancer, or that cancer is not 'top of mind' when respondents are asked about which diseases and conditions alcohol increases the risk of.

The association between alcohol and liver cancer was the most known among the respondents, whereas fewer were aware of the association between alcohol and the other cancer types. These findings are consistent with previous studies (Coomber et al., 2017; Buykx et al., 2015; Mandag Morgen A/S, 2009; Mahler Sørensen et al., 2015). The awareness of the association between alcohol and breast cancer was especially low compared to the other cancer types in this study. It can be speculated whether the low awareness of alcohol as a risk factor for breast cancer might be explained by the fact that it is not directly in contact with alcohol when it is consumed which is the fact for the liver, esophagus, head, neck and colorectal. Hence it may make less sense intuitively that alcohol increases breast cancer risk. According to some behavioral theories, the experience of meaning is an important component in understanding an association, which might be happening in this scenario, as well (Bartholomew et al., 2016).

4.2. Demographic factors and health behaviors associated with cancer awareness

Being female is a predictor for being aware that alcohol increases the risk of cancer, which is shown in studies from Australia and UK

Table 2
Awareness of alcohol as a risk factor for cancer (unprompted, prompted and specific cancer types) stratified by demographic factors and health behaviors in the study population (n = 3000) in Denmark 2017.

	Numbers (n)	Unprompted cancer awareness		Prompted cancer awareness		Breast cancer		Esophagus cancer		Head and neck cancer		Liver cancer		Colorectal cancer	
		Yes %	P-value from X^2-test	Yes %	P-value from X^2-test	Yes %	P-value from X^2-test	Yes %	P-value from X^2-test	Yes %	P-value from X^2-test	Yes %	P-value from X^2-test	Yes %	P-value from X^2-test
Total	3000	22.2	–	44.8	–	9.6	–	26.1	–	15.4	–	39.5	–	24.1	–
Sex															
Male	1500	19.5	< 0.001	40.1	< 0.001	6.9	< 0.001	22.4	< 0.001	13.9	0.020	34.9	< 0.001	21.6	0.001
Female	1500	24.9		49.5		12.3		29.9		16.9		44.2		26.7	
Age (years)															
18–29	654	22.9		43.9		9.3		23.5		17.0		38.8		23.9	
30–39	495	21.2		42		7.7		23.0		15.2		37.8		21.4	
40–49	560	26.2		49.1		8.4		28.0		15.9		42.9		26.6	
50–59	566	23.5		46.1		12.7		27.6		15.6		38.3		25.1	
60–74	725	18.2	0.011	43.3	0.135	9.5	0.05	28.0	0.104	13.7	0.546	39.7	0.447	23.6	0.367
Marital status															
Married	1445	23.4		45.5		9.7		28.0		15.4		40.7		25.0	
Cohibitant	524	19.5		42.9		10.1		23.5		14.9		38.9		25.4	
In a relationship (not cohibitant)	208	21.2		47.1		10.1		24.0		16.4		39.4		27.9	
Single	799	22.2	0.449	44.1	0.746	8.9	0.946	24.7	0.108	15.4	0.939	37.6	0.507	21.0	0.109
Other	24	25.0		50.0		8.3		37.5		20.8		50.0		16.7	
Educational level															
Primary school	310	16.1		39.7		11.3		22.9		11.6		34.8		23.2	
Vocational school	686	18.8		38.5		7.4		21.6		12.0		34		19.2	
Upper secondary	625	23.2		47.2		10.6		25.1		17.0		41.1		22.4	
Higher education < 2 year	440	16.1		39.5		6.6		23.6		14.1		33		22.5	
Higher education > 2 < 5 year	557	26.8		51		10.8		31.8		19.4		46.9		29.6	
Higher education > 5 year	359	33.4	< 0.001	54.9	< 0.001	12.3	0.031	33.7	< 0.001	18.9	< 0.001	48.5	< 0.001	31.5	< 0.001
Other	23	13.0		34.8		8.7		26.1		0.0		34.8		13.0	
Geographical region															
Capital	955	24.6		49.7		12.4		29.2		10.1		44		28.1	
Zealand	431	18.3		39.2		8.4		25.5		13.5		35.3		23.9	
Southern	629	23.9		43.4		8.4		26.6		17.5		38.8		22.4	
Central	677	21.6		44		7.5		23.4		13.2		36.8		22.3	
Northern	308	18.5	0.033	42.2	0.003	7.5	0.012	22.7	0.051	13.6	0.067	39.3	0.009	19.8	0.009
Alcohol consumption															
Below low limit risk	2457	22.6		45.1		9.4		26.4		15.6		39.7		24.2	
Between low and high limit risk	250	24.8		45.6		11.2		25.6		15.6		41.2		23.6	
Above high limit risk	146	18.5		46.6		12.3		28.1		15.8		43.2		28.8	
Don't know	147	15.0	0.077	37.4	0.311	6.8	0.329	21.1	0.506	10m9	0.49	29.9	0.079	19.7	0.346
Use of tobacco															
Never-smoker	1452	24.7		46.6		10.7		27.8		16.1		40.4		24.0	
Ex-smoker	823	24.7		47.9		10.0		28.9		16.0		42.7		26.5	
Current smoker	707	14.7		37.9		6.8		19.9		13.4		34.2		21.8	
Don't know	18	11.1	< 0.001	38.9	< 0.001	5.6	0.028	11.1	< 0.001	5.6	0.235	33.3	0.006	16.7	0.159

Table 3

Odds ratio for awareness of alcohol as a risk factor for cancer (unprompted, prompted and specific cancer types) according to demographic factors and health behaviors in the study population (n = 3000) Denmark in 2017

	Unprompted cancer awareness		Prompted cancer awareness		Breast cancer		Esophagus cancer		Head and neck cancer		Liver cancer		Colorectal cancer	
	OR	95% CI	OR	95% CI	OR[a]	95% CI	OR[a]	95% CI	OR[a]	95% CI	OR[a]	95% CI	OR[a]	95% CI
Sex														
Male[ref.]	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Female	1.39**	(1.16–1.66)	1.46**	(1.26–1.70)	1.94**	(1.50–2.51)	1.46*	(1.24–1.73)	1.24*	(1.01–1.52)	1.48**	(1.27–1.72)	1.33**	(1.12–1.58)
Age (years)														
18–29[ref.]	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
30–39	0.86	(0.64–1.17)	0.97	(0.75–1.25)	0.90	(0.57–1.42)	0.92	(0.68–1.23)	0.87	(0.62–1.22)	0.97	(0.75–1.26)	0.82	(0.60–1.10)
40–49	1.12	(0.84–1.43)	1.33*	(1.03–1.72)	1.06	(0.68–1.65)	1.22	(0.91–1.63)	0.93	(0.66–1.31)	1.24	(0.96–1.61)	1.15	(0.86–1.54)
50–59	1.00	(0.73–1.37)	1.25	(0.96–1.63)	1.81	(118–2.77)	1.28	(0.95–1.73)	0.98	(0.69–1.39)	1.07	(0.82–1.40)	1.13	(0.84–1.54)
60–74	0.70*	(0.51–0.97)	1.11	(0.85–1.45)	1.22	(0.77–1.91)	1.30	(0.96–1.75)	0.83	(0.58–1.19)	1.12	(0.85–1.46)	1.04	(0.76–1.41)
Marital status														
Married[ref.]	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Cohibitant	0.71*	(0.54–0.93)	0.91	(0.72–1.13)	1.13	(0.78–1.65)	0.85	(0.65–1.10)	0.86	(0.63–1.17)	0.93	(0.74–1.17)	1.05	(0.81–1.36)
In a relationship (not cohabitant)	0.83	(0.57–1.21)	1.11	(0.81–1.52)	1.08	(0.65–1.81)	0.89	(0.62–1.28)	0.99	(0.65–1.50)	0.99	(0.72–1.35)	1.20	(0.85–1.69)
Single	0.95	(0.76–1.18)	0.96	(0.80–1.16)	0.91	(0.66–1.25)	0.89	(0.72–1.10)	0.98	(0.76–1.26)	0.89	(0.73–1.07)	0.81	(0.65–1.01)
Other	1.16	(0.44–3.02)	1.15	(0.50–2.62)	0.74	(0.17–3.24)	1.39	(0.59–3.28)	1.40	(0.51–3.85)	1.35	(0.59–3.07)	0.55	(0.18–1.63)
Educational level														
Primary school[ref.]	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Vocational school	1.15	(0.80–1.66)	0.96	(0.72–1.27)	0.60*	(0.37–0.95)	0.94	(0.68–1.31)	1.02	(0.67–1.56)	0.99	(0.74–1.32)	0.79	(0.56–1.09)
Upper secondary	1.44	(0.98–2.11)	1.43*	(1.06–1.93)	0.93	(0.58–1.50)	1.31	(0.93–1.86)	1.48	(0.96–2.28)	1.37*	(1.01–1.86)	0.95	(0.67–1.35)
Higher education < 2 year	0.84	(0.56–1.27)	0.94	(0.69–1.28)	0.52*	(0.30–0.89)	1.06	(0.74–1.52)	1.12	(0.74–1.84)	0.87	(0.63–1.20)	0.93	(0.65–1.34)
Higher education > 2 < 5 year	1.61*	(1.11–2.33)	1.50*	(1.12–2.02)	0.88	(0.55–1.39)	1.56*	(1.12–2.18)	1.69*	(1.11–2.57)	1.57*	(1.17–2.12)	1.34	(0.96–1.86)
Higher education > 5 year	2.33**	(1.57–3.45)	1.85**	(1.33–2.56)	1.04	(0.63–1.73)	1.86**	(1.30–2.68)	1.68*	(1.07–2.65)	1.77**	(1.27–2.46)	1.50*	(1.04–2.16)
Other	0.74	(0.21–2.62)	0.81	(0.33–1.98)	0.68	(0.15–3.13)	1.25	(0.47–3.33)	1.00	(n = 0)	1.02	(0.41–2.51)	0.5	(0.14–1.75)
Geographical region														
Capital[ref.]	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Zealand	0.72*	(0.54–0.93)	0.68*	(0.54–0.86)	0.65*	(0.43–0.97)	0.85	(0.65–1.11)	0.81	(0.58–1.13)	0.72*	(0.56–0.91)	0.83	(0.63–1.09)
Southern	1.03	(0.81–1.31)	0.81	(0.66–1.00)	0.67*	(0.48–0.97)	0.89	(0.71–1.13)	1.07	(0.82–1.41)	0.84	(0.68–1.04)	0.76*	(0.59–0.96)
Central	0.88	(0.69–1.12)	0.83	(0.68–1.02)	0.67*	(0.49–0.94)	0.76*	(0.60–0.96)	0.77	(0.58–1.02)	0.77*	(0.63–0.95)	0.76*	(0.61–0.97)
Northern	0.73	(0.53–1.02)	0.78	(0.60–1.01)	0.57*	(0.35–0.92)	0.73*	(0.54–0.99)	0.82	(0.56–1.19)	0.87	(0.66–1.14)	0.67*	(0.48–0.92)
Alcohol consumption														
Below low risk limit[ref.]	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Between low and high limit risk	1.17	(0.85–1.60)	0.98	(0.75–1.28)	1.15	(0.75–1.77)	0.90	(0.66–1.23)	1.00	(0.69–1.44)	1.00	(0.76–1.32)	0.90	(0.66–1.24)
Above high risk limit	0.93	(0.60–1.45)	1.18	(0.83–1.66)	1.55	(0.91–2.63)	1.19	(0.81–1.75)	1.09	(0.68–1.75)	1.24	(0.87–1.76)	1.34	(0.91–1.96)
Don't know	0.68	(0.42–1.09)	0.78	(0.55–1.12)	0.73	(0.37–1.43)	0.82	(0.54–1.24)	0.71	(0.42.1.22)	0.74	(0.48–1.01)	0.81	(0.53–1.25)
Use of tobacco														
Never-smoker[ref.]	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Ex-smoker	1.10	(0.89–1.36)	1.09	(0.91–1.30)	0.87	(0.65–1.18)	1.03	(0.84–1.25)	1.06	(0.83–1.35)	1.12	(0.93–1.34)	1.13	(0.92–1.39)
Current smoker	0.56**	(0.43–0.71)	0.73**	(0.60–0.88)	0.60*	(0.42–0.84)	0.68**	(0.54–0.85)	0.84	(0.64–1.09)	0.80*	(0.66–0.97)	0.91	(0.73–1.14)
Don't know	0.39	(0.09–1.73)	0.75	(0.28–1.97)	0.45	(0.06–3.41)	0.35	(0.08–1.52)	0.32	(0.04–2.43)	0.78	(0.29–2.12)	0.69	(0.20–2.43)

ref. Reference group.

[a] Adjusted odds ratios (all variables are included in the model) **p < 0.001 * p < 0.05.

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(Kippen et al., 2017; Sanderson et al., 2009; Buykx et al., 2015). Like our study, Buykx et al. also (Buykx et al., 2015) found, that being female was associated with both higher unprompted and prompted cancer awareness as well as awareness of alcohol as a risk factor for specific cancer types compared to being male.

Previous studies from Denmark and UK have found that the level of awareness of alcohol as a risk factor for cancer follows a socioeconomic gradient from low to high (Redeker et al., 2009; Hvidberg et al., 2014; Wagner et al., 2011), which is consistent with our findings where we found that awareness of alcohol as a risk for cancer increases with higher education level, especially with having a higher education of 2 or more years compared to only having primary school.

Lastly, previous studies showed that awareness of the link between alcohol and cancer is associated with geographical region. We found some regional differences, with a tendency indicating that living outside the Capital Region of Denmark was associated with lower awareness compared to living in the Capital Region of Denmark. Both Coomber et al. and Buykx et al. found that people living outside the metropolitan areas had lower awareness of the link between alcohol and cancer compared to people living in metropolitan areas (Coomber et al., 2017; Buykx et al., 2015). Even though we adjusted for educational level, the regional differences might still be attributed to socioeconomic status in terms of income and occupation.

Being a never-smoker was associated with greater awareness of alcohol as a risk factor for cancer both unprompted, prompted and in terms of breast cancer, esophagus cancer and liver cancer, which is similar to results in the study by Sanderson et al (Sanderson et al., 2009).

There were no significant statistical associations between awareness of alcohol as a risk factor for cancer and the respondents' age and marital status. Previous research indicates that the association between awareness and age is inconsistent, and we did not find any other research that had examined the association between cancer awareness and marital status before. We found no difference between the level of intake of alcohol by the respondents and their awareness of the link between alcohol of cancer neither unprompted, prompted nor in terms of specific cancer types, which were surprising, since knowledge of risk factors usually affects behavior. Similar results were found in previous studies from England and Australia (Coomber et al., 2017; Buykx et al., 2015; Clive, 2013), although we measured alcohol consumption differently.

Combined, these results indicate that awareness of alcohol as a risk factor for cancer is not widespread in the Danish population. Therefore, future information about the link between alcohol and cancer should be spread to all Danes to gain higher awareness. This could lead to lower alcohol consumption among Danes and thereby fewer alcohol-related cancer incidence. We have shown that knowledge about the association between alcohol and different cancer types varies. It can therefore be relevant to inform that alcohol does not only cause liver cancer, but can also cause multiple other cancer types. Furthermore, it could also be beneficial to target subgroups separately in regards to sex and different levels of education, especially targeting male and people with lower education.

4.3. Study strengths and limitations

The study population was recruited from the market research company Voxmeter's web panel. The recruitment of respondents was done by telephone in order to avoid self-selection that may be associated with self-registration via websites and advertisements. Furthermore, respondents were recruited in quotas that ensured that the respondents were nationally representative in relation to sex, age and geographical region. However, the use of panel data is a limitation of this study, as it is possible that respondents recruited from a web panel differ from the general population (Strandhagen et al., 2010). Panel members may be more highly-educated, curious and information-seeking compared to the background population. If so, then it may lead to an overestimation of how many Danes actually are aware of the link between alcohol and cancer.

There is no golden standard for measuring awareness of alcohol as a risk factor for cancer. This study shows that there is a big difference in awareness of the link between alcohol and cancer in terms of unprompted or prompted awareness. We found that twice as many respondents (44.8% vs. 22.2%) were aware of the association when asked prompted compared to unprompted. An Australian study has examined the importance of estimating awareness of cancer risk factors unprompted and prompted, respectively. The study has generally shown a statistically significant higher awareness of risk factors when questions followed by different possible answers (prompted) compared with questions without any options (unprompted) (Walle et al., 2004). When an open-ended question is formulated, respondents may wish to skip it quickly by mentioning some of the diseases that come to mind and when cancer is listed as a possible answer, respondents may tick it off even though they do not know that alcohol increases the risk of cancer (Scheideler and Klein, 2018; Buykx et al., 2015). In order to gain a nuanced understanding of the subject, we chose to measure both unprompted and prompted cancer awareness.

5. Conclusions

This study shows a generally low awareness of the link between alcohol and cancer in the Danish population, both regarding cancer in general but also concerning specific types of cancer. This indicates that there is a need to create a heavier emphasis on communicating the link between alcohol and cancer to the public in general and maybe with a special focus on targeting the subgroups where the level of awareness is lowest, such as males, people with lower education, people living outside the Capital Region of Denmark, and people who smoke.

CRediT authorship contribution statement

Karen Linding Thomsen: Conceptualization, Methodology, Formal analysis, Visualization. **Anne Sofie Plum Christensen:** Methodology, Writing - review & editing. **Maria Kristine Hagelskær Meyer:** Conceptualization, Methodology, Writing - review & editing, Supervision, Project administration.

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.

Appendix. **Trend analysis for unprompted awareness, prompted awareness and specific cancer types according to the respondents' age and educational level.**

	Age		Educational level*	
	OR[a]	P-trend	OR[b]	P-trend
Unprompted awareness	0.94 (0.87–1.01)	0.088	1.13 (1.07–1.20)	< 0.001
Prompted awareness	1.04 (0.98–1.11)	0.209	1.11 (1.06–1.17)	< 0.001
Breast cancer	1.11 (1.00–1.23)	0.058	1.04 (0.96–1.03)	0.371
Esophagus cancer	1.09 (1.01–1.16)	0.021	1.14 (1.08–1.20)	< 0.001
Head and neck cancer	0.97 (0.89–1.06)	0.505	1.10 (1.03–1.17)	0.005
Liver cancer	1.03 (0.97–1.10)	0.364	1.11 (1.06–1.17)	< 0.001
Bowl cancer	1.04 (0.96–1.11)	0.338	1.12 (1.06–1.18)	< 0.001

*'Other'-category is excluded [a]Adjusted for sex, marital status, educational level, geographical region, alcohol consumption and use of tobacco.
[b]Adjusted for sex, age, marital status, geographical region, alcohol consumption and use of tobacco.

References

Bagnardi, V., Rota, M., Botteri, E., Tramacere, I., Islami, F., Fedirko, V., 2015. Alcohol consumption and site-specific cancer risk: a comprehensive dose-response meta-analysis. Br. J. Cancer 112 (3), 580–593.

Bartholomew, L., Markham, C., Ruiter, R. Planning Health Promotion Programs – An Intervention Mapping Approach. 4. Udgave. Jossey-Bass;2016.

Buykx, P., Li, J., Gavens, L., Hooper, L., Lovatt, M., Gomes de Matos, E., 2016. Public awareness of the link betwen alcohol and cancer in England in 2015: a population-based survey. BMC Public Heath 16 (1), 1194.

Buykx, P., Gilligan, C., Ward, B., Kippen, R., Chapman, K., 2015. Public support for alcohol policies associated with knwoledge of cancer risk. Int. J. Drug Policy 26 (4), 371–379.

Christensen, A.S.P., Meyer, M.K.H., Dalum, P., Krarup, A.F., 2019. Can a mass media campaign raise awareness of alcohol as a risk factor for cancer and public support for alcohol related policies? Prev. Med.

Coomber, K., Mayshak, R., Curtis, A., Miller, P.G., 2017. Awareness and correlates of short-term and long-term consequences of alcohol use among Australian drinkers. Aust. N Z J. Public Health 41 (3), 237–242.

Cotter, Perez, D., Dunlop, S., Kite, J., Gaskin, C., 2013. Knowledge and beliefs about alcohol consumption, longer-term health risks, and the link with cancer in a sample of Australian adults. New South Wales Public Health Bull. 24 (2), 81–86.

Dixon, H.G., Pratt, I.S., Scully, M.L., Miller, J.R., Patterson, C., Hood, R., 2015. Using a mass media campaign to raise women's awareness of the link between alcohol and cancer: a cross-sectional pre-intervention and post-intervention evaluation surveys. BMJ Open 5 (3).

Hvidberg, L., Pedersen, A.F., Wulff, C.N., Vedsted, P., 2014. Cancer awareness and socio-economic position: results from af population-based study in Denmark. BMC Cancer 14, 581.

International Agency for Research on Cancer, 1988. IARC Monographs on the Evaluation of the Carcinogenic Risk to Humans. World Health Organization, Lyon, France.

International Agency for Research on Cancer, 2010. IARC Monographs on the Evaluation of the Carcinogenic Risk to Humans. World Health Organization, Lyon, France.

Jensen, H., Davidsen, M., Ekholm, O., Christensen, A., Danskernes Sundhed – Den Nationale Sundhedsprofil 2017. København: Sundhedsstyrelsen; 2018 [In Danish].

Kippen, R., James, E., Ward, B., Buykx, P., Shamsullah, A., Watson, W., 2017. Identificiation of cancer risk and associated behaviour: implications for social marketing campaigns for cancer prevention. BMC Cancer 17 (1), 550.

Lagerlund, M., Hvidberg, L., Hajdarevic, S., Fischer Pedersen, A., Runesdotter, S., Vedsted, P., 2015. Awareness of risk factors for cancer: a comparative study of Sweden and Denmark. BMC Public Health 15, 1156.

Mahler Sørensen, M., Sommer, N., Christensen, A., Behrens, C., 2015. Danskernes holdning til unges alkoholvaner 2014. Kræftens Bekæmpelse og TrygFonden, København [In Danish].

Mandag Morgen A/S, TrygFonden. Fremtidens alkoholpolitik – ifølge danskerne. København: Tænketanken Mandag Morgen; 2009 [In Danish].

OECD Data. Alcohol consumption (cited 02.06.20). Available from: https://data.oecd.org/healthrisk/alcohol-consumption.htm.

Redeker, C., Wardle, J., Wilder, D., Hiom, S., Mile, A., 2009. The launch of Cancer Research UK's "Reduce the Risk" campaign: baseline measurements of public awareness of cancer risk factors in 2004. Eur. J. Cancer Oxf. Engl. 45 (5), 827–836.

Sanderson, S.C., Waller, J., Jarvis, M.J., Humphries, S.E., Wardle, J., 2009. Awareness of lifestyle risk factors for cancer and heart disease among adults in the UK. Patient Educ. Couns. 74 (2), 221–227.

Scheideler, J.K., Klein, W.M.P., 2018. Awareness of the link between alcohol consumption and cancer across the world: a review. Cancer Epidemiol. Biomarkers Prev. 27 (4), 429–437.

Scheideler, J.K., Klein, W.M.P., 2018. Awareness of the link between alcohol consumption and cancer across the world: a review. Cancer Epidemiol. Biomarkers Prev. 27 (4), 429–437.

Schütze, M., Boeing, H., Pisechon, T., Rehm, J., Kehoe, T., 2011. Gmel G, m.fl. Alcohol attributable burden of incidence of cancer in eight European countries based on results from prospective cohort study. BMJ 342, d1584.

Strandhagen, E., Berg, C., Lissner, L., Nunez, L., Rosengren, A., Torén, K., 2010. Selection bias in a population survey with registry linkage: potential effect on socioeconomic gradient in cardiovascular risk. Eur. J. Epidemio. 25 (3), 163–172.

Sundhedsstyrelsen. Kampagner (cited 24.06.19). Available from: https://www.sst.dk/da/opgaver/forebyggelse/indsatser/alkohol [In Danish].

Wagner, Good, A., Whitaker, K.L., Wardle, J., 2011. Psychosocial determinants of socioeconomic inequalities in cancer screening participation: a conceptual framework. Epidemiol. Rev. 33, 135–147.

Walle, J., McCaffery, K., Wardle, J., 2004. Measuring cancer knowledge: comparing prompted and unprompted recall. Br. J. Psychol. Lond. Engl. 95 (Pt 2), 219–234.

WHO. Global Status Report on Alcohol and Health 2018.