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Associations between alcohol and tobacco consumption and overall cancer mortality

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Background and research questions

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Previous epidemiology studies found a strong dose-response/risk relation between long-term alcohol and tobacco use and various cancers (American Institute for Cancer Research, 2007; International Agency for Research on Cancer, 2012).

- long-term alcohol use increases risk of cancers at seven sites: oropharynx, larynx, oesophagus, liver, colon, rectum and female breast,
- long-term tobacco smoking is associated with cancers of the lips, oral cavity, pharynx, larynx, lung, stomach, colorectum, breast, pancreas and liver.

1) Is population-level consumption of alcohol and tobacco related to cancer mortality ?

Background and research questions

Case-control and prospective studies have found that links between alcohol and tobacco use and cancer diseases vary across gender and age groups.

2) We wonder do temporal associations between population alcohol and tobacco consumption and cancer mortality differ in different gender and age groups?

There have been no previous aggregate-level studies of cancer mortality to inform the specification of the appropriate lag structures.

3) What are the cumulative lagged effects, lag structure and length at the population level of drinking and tobacco smoking on cancer mortalities?

Data

Alcohol consumption per capita (aged 15+) data from 1935 to 2014 were collected from the Australian Bureau of Statistics.

Tobacco consumption per capita (aged 15+) data from 1935 to 2014 were collected from Cancer Council Victoria (Scollo and Winstanley, 2015) and KPMG's report, *Illicit Tobacco in Australia* (KPMG, 2016).

Age- and gender-specific cancer mortality data (rate per 100,000 inhabitants) from 1968 to 2014 were collected from the Australian Institute of Health and Welfare .

Health expenditure per capita from 1960 to 2014 collected from OECD database was used as the control variable in the analysis.

Method – time series model

The semi-log autoregressive integrated moving average (ARIMA) modelling technique was employed to estimate the association between per-capita alcohol consumption and overall cancer mortality.

$$\Delta LogCM_t = \alpha + \beta \Delta WALC_t + \gamma \Delta WTOB_t + \mu \Delta C_{i,t} + \Delta E_t$$

The coefficient values β or γ indicate the proportional change in cancer mortality rate associated with a 1-litre change in weighted per-capita alcohol consumption or a 1 kg change in weighted per capita tobacco consumption $\left(e^{\beta} - 1\right) \times 100$.

Method – lag structure and lag length

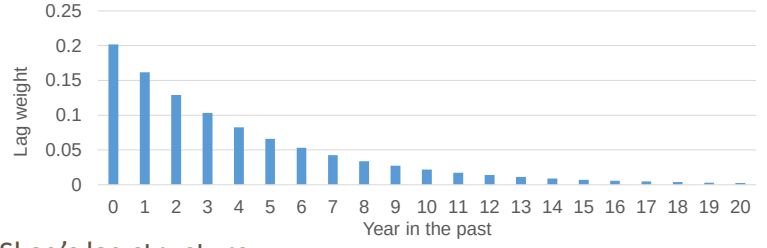
To the best of our knowledge, no specific lag structure or length has been discussed in previous aggregate analyses on alcohol, tobacco and cancer mortalities.

We proposed three different lag structures in the analysis.

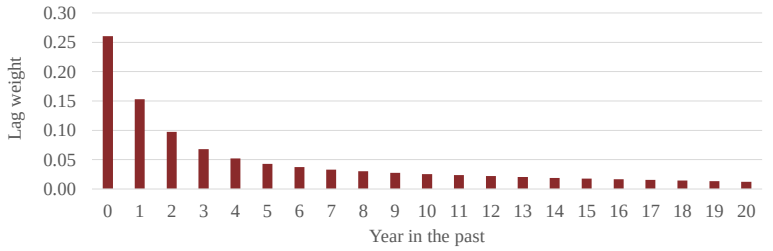
- A geometrical lag scheme $\frac{X_n + 0.7^2 X_{n-1} + \cdots + 0.7^{n-1} X_2 + 0.7^n X_1}{1 + 0.7 + 0.7^2 + \cdots + 0.7^{n-1} + 0.7^n}$
- Skog's lag structure $W_t = p\theta\,{}^{t}_{1} + (1-p)\theta\,{}^{t}_{2}$
- Cross-correlation lag structure

Method – lag structure and lag length

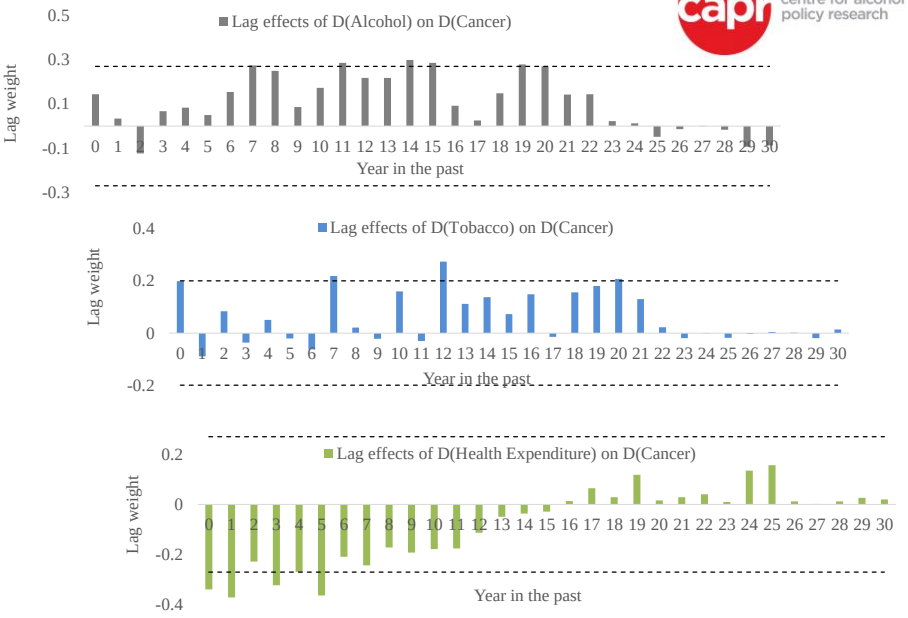
- A geometrical lag scheme



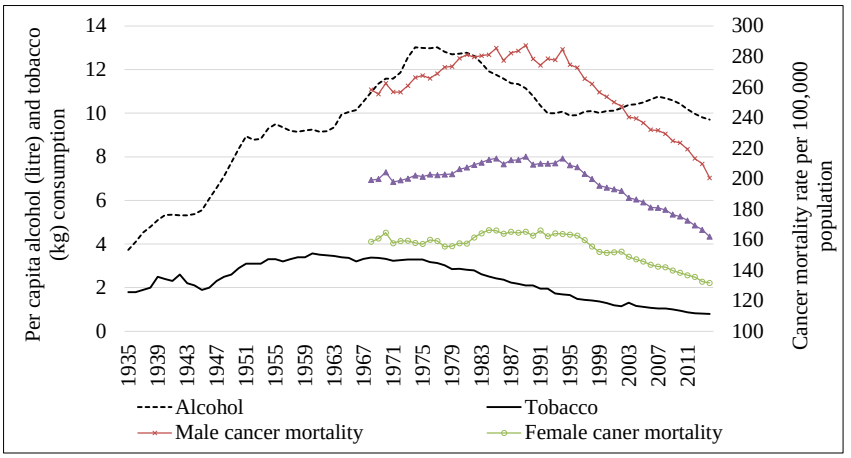
- Skog's lag structure



Method – cross correlation lag



Results – Figure 1 Trend of alcohol and tobacco consumption and overall cancer mortalities



Results – Table 1 estimates of temporal associations

	Male cancer		Female cancer		Total cancer	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Model with 20 years geometric lags						
Alcohol	0.005	0.021	0.031	0.022	0.014	0.018
Tobacco	-0.078	0.115	-0.154	0.126	-0.093	0.100
Health expenditure (5 yrs geometric lag)	-0.105*	0.046	-0.161*	0.026	-0.124*	0.039
Constant	-0.000	0.008	-0.001	0.007	-0.001	0.007
R-square	0.155		0.318		0.260	
Model with 20 years Skog's lags						
Alcohol	0.061*	0.030	0.018	0.028	0.038	0.023
Tobacco	-0.239	0.134	-0.114	0.127	-0.170	0.101
Health expenditure (5 yrs Skog lag)	-0.158**	0.049	-0.105*	0.046	-0.128**	0.037
Constant	-0.005	0.009	-0.002	0.008	-0.003	0.007
R-square	0.358		0.156		0.349	
Model with 20 years cross-correlation lags						
Alcohol	0.043*	0.016	0.035*	0.013	0.038**	0.012
Tobacco	0.266**	0.077	0.083	0.076	0.151***	0.037
Health expenditure (5 yrs cross-correlation lag)	-0.046	0.052	-0.042	0.056	-0.047	0.041
Constant	0.010*	0.005	-0.002*	0.005	0.005	0.004
R-square	0.582		0.467		0.589	

Results – Table 2 Estimates of temporal associations between alcohol and tobacco consumption and gender- and age-specific cancer mortality based on cross-correlation lags

	Alcohol consumption		Tobacco consumption		Model specification	Box-Ljung Q (lag 10)
	Estimate	S.E.	Estimate	S.E.		
Male						
30-49	0.032	0.086	0.137	0.621	1,1,0	6.404, p=0.699
50-69	0.095***	0.028	0.170*	0.102	1,1,0	10.883, p=0.284
70+	0.016	0.026	0.263**	0.096	0,1,0	8.350, p=0.595
Subtotal	0.043*	0.016	0.266**	0.077	1,1,0	9.546, p=0.389
Female						
30-49	0.022	0.037	0.070	0.128	1,1,0	5.080, p=0.749
50-69	0.059**	0.046	0.063	0.109	0,1,0	8.576, p=0.573
70+	0.042*	0.011	0.067	0.042	0,1,1	7,357, p=0.600
Subtotal	0.035*	0.023	0.083	0.076	0,1,1	4.996, p=0.835

Conclusions

- The results of lag length and lag effects analyses suggested that there were 20 years of cumulative lagged effects of drinking and smoking on cancer mortality at the population level, with the highest lagged effects in 14th and 12th years respectively

- Comparing the three model outputs, the model with 20 years cross-correlation-lagged alcohol and tobacco consumption shows significant associations between alcohol and tobacco consumption and overall, male and female cancer mortality rates and achieved higher R-square values and lower standard error in the estimation.

- The model estimates suggest that a 1-litre decrease in per capita alcohol consumption can reduce overall cancer mortality 3.9%, while a 1 kg decrease in per capita tobacco consumption can lead to a reduction of overall cancer mortality by 16% across a 20-year period, controlling for the trend of health expenditure per capita.

Conclusions

- Stronger and significant associations were found between per capita alcohol consumption and mortality among males aged 50-69 and females aged 50+. Significant association was found between per capita tobacco consumption and cancer mortality among males aged 50+ and females aged 70+.

- Based on our estimation, if the tobacco smoking is totally banned in Australia (per capita tobacco consumption in 2014 is 0.8kg), cancer mortality will be reduced by 12.8% in a 20-year period, which is consistent with the results of a recent Australian tobacco epidemiological study that in total 13% of cancer deaths in Australian were attributable to tobacco smoke (Pandeya et al., 2015).

- Our findings also suggest that if the current Australian population drinking level can be limited (9 litre per capita in 2014) to 6 litres per capita, the overall cancer mortality will be reduced by 11.7% across a 20-year period.

Conclusions

- This exploratory study provides the first evidence from an aggregate-level temporal analysis that a decrease in population level drinking and smoking can reduce overall cancer mortality, particularly among older age males and females. Public health policies on alcohol and tobacco are recommended to work together and learn from each other to minimize the long-term adverse health effects on cancer from these two risky behaviours.
- We also found significant and negative associations between health expenditure and cancer mortality in older age groups, suggesting that an increase in health expenditure per person can reduce cancer mortality rate or increase cancer survivor rate within a five year period.

Limitations:

Some confounding factors associated with cancer mortality were not examined in this study. The prevalence rates of drinking and smoking were not considered and year by year gender and age-specific alcohol and tobacco consumption are unavailable in Australia.

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THANK YOU !

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