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Alcohol-related emergency department (ED) presentations and persons of interest proceeded against by police for assault

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Aim: *To examine the association between risky alcohol use and police proceedings for assault.*

Method: *Alcohol-related emergency department (ED) data were obtained from NSW Health for males and females aged 13-17, 18-24 and 25-64 years. Data on persons of interest (POIs) proceeded against for assault or use/possess amphetamines were obtained from NSW police for the same age/gender groups. Time series analyses were conducted using monthly data from 2004 through 2016. Within each age/gender group, regression modelling predicted the number of persons proceeded against for assault using alcohol-related ED presentations at various lags as a predictor. Persons proceeded against for use/possess amphetamines was used as a covariate as this could be a competing explanation for changes in the incidence of assault POIs.*

Results: *The relationship between alcohol-related ED presentations and the number of persons proceeded against by the police for assault varied by age group and gender. Among 13-17 year old males each 10 additional alcohol-related ED presentations was associated with: 4.1 additional persons proceeded against for assault during the same month and 4.5 additional persons two months later. Among 18-24 year old males, each 10 additional alcohol-related ED presentations was associated with 5.9 additional assault POIs during the same month and 8.2 additional assault POIs one month later. Among 25-64 year old males the same sized increase in alcohol-related ED presentations was associated with 5.4 additional assault POIs during the same month. Alcohol-related ED data predicted the decline since 2009 in 13-17 year old male persons who were proceeded against for assault. It also predicted the increase which occurred among 25-64 year old males proceeded against for assault from 2004-2009 and from 2012-2016. The relationship between alcohol-related ED presentations and persons proceeded against for assault was much smaller for females compared with males. While no relationship was found for females aged 13-17 years, significant effects were found for the two older age groups. Among females aged 18-24 years an increase in the number of alcohol-related ED presentations by 10 was associated with persons proceeded against for assault increasing by 1.5 during the same month. For females aged 25-64 years, an increase in the number of alcohol-related ED presentations by 10 was associated with 2.4 more assault POIs during the same month and 1.8 more during the next month. The increase in alcohol-related ED presentations for females aged 25-64 predicted the increase in persons proceeded against for assault which occurred for this group from 2004-2009 and from 2013-2016.*

Conclusion: *Violence arising from risky alcohol use imposes a substantial burden on police and the court system.*

Keywords: *alcohol, emergency department presentations, assault, persons of interest, time series analyses, ARIMA*

INTRODUCTION

There are several lines of evidence which show that as the prevalence of risky alcohol use increases so does the number of assaults. This includes higher assault levels in locations close to licenced premises (Burgess & Moffatt, 2011), higher assault rates in local areas which have a higher number of licensed premises (Donnelly, Menéndez, & Mahoney, 2014; Stockwell et al., 2013; Toomey et al., 2012), higher assault rates in areas with higher alcohol sales (Liang & Chikritzhs, 2011), higher self-reports of violence by heavy drinkers (Makkai, 1998; Weatherburn, 2001) and a close correlation between emergency department presentations for alcohol problems and reports of assault (Descallar, Muscatello, Weatherburn, Chu, & Moffatt, 2011).

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Evidence has emerged from both household and school-based surveys that risky alcohol use has recently decreased among both adolescents and young adults. The National Drug Strategy household survey found that the proportion of 18-24 year olds who consumed 11 or more standard drinks at least monthly declined from almost one quarter in 2010 to around 15 per cent in 2016. The decline was not as large for 25-29 year olds and no declines were apparent for the older age groups; although the absolute percentage was lower (Australian Institute of Health and Welfare, 2017). In the Australian Secondary Students Alcohol and Drug (ASSAD) school surveys conducted throughout Australia there has been a sharp decline in the percentage of 12-15 year olds who report having consumed any alcohol in the previous seven days; from over one quarter in 2002 to 10 per cent in 2014. Among 16-17 year olds there has been a significant decline in the percentage reporting having consumed five or more drinks on one occasion in the past seven days; from 18 per cent in 2008 to 13 per cent in 2014 (White & Williams, 2016).[1]

Over this same period there was also a decline in the number of younger persons proceeded against by police in NSW for assault. Among 18-24 year olds the number of males and females proceeded against for non-domestic violence assault fell from 3,861 in 2010 to 2,706 in 2016. For 13-17 year olds the number of males and females proceeded against for non-domestic violence assault fell from 3,074 in 2008 to 1,940 in 2014 and to 1,678 in 2016.[2]

Although the link between alcohol use and assault has received a great deal of scholarly attention, the impact of alcohol use (or alcohol consumption more generally) on the criminal justice system has received much less attention. This is unfortunate because being able to identify and measure the key drivers of demand for criminal justice resources would help in avoiding problems of court and prison congestion. The number of persons brought before the NSW Courts for an 'act intended to cause injury' (most of which are assaults) increased by 38 per cent between 2003/4 and 2016/17. Across Australia over this same period the increase has been even larger (56%). The category 'acts intended to cause injury' now accounts for the majority of persons sentenced to a term of imprisonment and is now the top contributor to imprisonment rate growth in NSW and Australia as a whole (Australian Bureau of Statistics, 2018).[3] Some understanding of the factors that might be driving these changes would help greatly in planning an appropriate response to them.

The current study uses emergency department (ED) data from NSW Health to determine if there is a relationship over time between risky alcohol use and the number of persons of interest (POIs) proceeded against by NSW police for assault (assault POIs). We focus on ED presentations for risky alcohol use because it is a useful proxy for overall levels of risky alcohol consumption in the broader community. The analysis covers the 156 month period between January 2004 and December 2016.

Separate analyses were conducted in relation to age groups (13-17 years; 18-24 years and 25-64 years) and gender. These separate analyses are conducted because age and gender are relevant to court and prison administration.

Alcohol is not the only drug likely to influence levels of assault. Prolonged use of psycho-stimulants such as methamphetamine can have a similar effect with increased levels of assault (McKetin et al., 2014). During the period covered by this study, NSW experienced a rapid growth in methamphetamine ED presentations (NSW Ministry of Health, 2018). Past research has shown a strong relationship between use/possession of amphetamines recorded by police and ED presentations for amphetamine type substances (Moffatt, Wan, & Weatherburn, 2012). We therefore adjust for changes in methamphetamine use over time using police data on the number of persons proceeded against by police for use/possess amphetamines.

Research Questions:

1. Is there a significant positive association between alcohol-related emergency department (ED) presentations and the number of persons police proceeded against for assault?
2. Does this association vary by age and gender?

METHOD

DATA

Emergency department data: The Centre for Epidemiology and Evidence, NSW Health provided Emergency Department data for this investigation from 52 hospitals. These 52 hospitals account for approximately 73% to 76% all NSW public hospital ED presentations. The Public Health Rapid Emergency, Disease and Syndromic Surveillance (PHREDSS) system maps principal diagnosis codes to a range of categories. The category we used was 'alcohol problems' surveillance syndrome which includes ICD-9-CM, ICD-10-AM and SNOMED-CT codes for acute intoxication, chronic dependence and withdrawal (Whitlam et al., 2016). The data provided covers 156 months between January 2004 and December 2016 (inclusive) broken down by gender and age group (13-17 years old; 18-24 years old, and; 25-64 years old).

COPS data: Monthly POI data broken down by age, gender and assault type were obtained from the NSW Computerised Operational Policing System (COPS). Assault data are normally divided into three categories: non-domestic violence (non-DV) assault; domestic violence (DV) assault and assault police officer. DV and non-DV assault data were combined for the purpose of the current study as the main question is about the total number of POIs for assault which the criminal justice system dealt with. The much smaller number of persons who were proceeded against for assault police officer were excluded from the POI total because trends in assault police officer are strongly affected

by policing policy. A POI is defined as having been proceeded against if police issue a court attendance notice, a youth justice conference, a caution or an infringement notice. Persons proceeded against for serious assault were also identified where the police recorded that there was actual bodily harm or grievous bodily harm. Data from COPS were also used to identify the monthly number of persons proceeded against for use/possess amphetamines. The number of use/possess amphetamines POIs was used as a covariate in the ARIMA models.

STATISTICAL ANALYSES

Stationary time series

An important assumption of ordinary least squares regression is that the residuals are independent (or uncorrelated) with each other. With time series data this independence of residuals assumption is often violated with adjacent time points (lag 1) being autocorrelated. With monthly data autocorrelation can also occur at longer lags such as two or even 12. When autocorrelation is present, autoregressive or moving average terms need to be included in the ARIMA model. It is important that a time series be made stationary so that the extent to which the residuals are autocorrelated can be estimated (Box, Jenkins, & Reinsel, 1994; Chatfield, 2004; Hyndman & Athanasopoulos, 2018). A series can be made *difference stationary* by subtracting the previous time point value from the current time point value. There are two advantages to making a series difference stationary. The first advantage is where adjacent time points are almost perfectly correlated and have a stochastic unit root. Differencing the series (once) generally removes this stochastic unit root. The second advantage to differencing is that the series has been transformed so that each time point shows the change which has occurred compared with the previous time point.

The alternative is to make a series *trend stationary* by including a deterministic trend term in an ARIMA regression model. Procedures such as the augmented Dickey-Fuller test and the Phillips-Perron test provide methods to determine if a time series is difference stationary or trend stationary (Enders, 2015). Table A1 in Appendix A shows the findings from applying the augmented Dickey-Fuller test for the various time series used for males and females respectively aged 13-17 years. Looking at the first row in Table A1 which is for assault among male POIs aged 13-17 years, the test statistic is not significantly different from zero ($Z(t) = -0.423$, $p = .529$). This means the series has a stochastic unit root and needs to be differenced. The second row shows the augmented Dickey-Fuller test for the assaults POI series after it has been differenced. The test statistic for this differenced series is significantly different from zero ($Z(t) = -10.748$, $p < .001$ ***), meaning that it has been made difference stationary.

As a result of conducting the augmented Dickey-Fuller tests for the four series within the age group/gender breakdowns, it was decided to difference all the series shown in Tables A1, A2 and A3. While the null hypothesis of a stochastic unit root was generally rejected for the 25-64 year olds (shown in Table A3), it was decided to difference these series in any case. The main justification for differencing the series for the 25-64 year olds was that what was being modelled for these males and females was the change which occurred at the current time point compared with the previous time point.

ARIMA analyses

In examining the relationship between alcohol-related ED presentations and the number of persons proceeded against for assault we used ARIMA modelling to explore the possibility of lagged as well as contemporaneous effects. A lag of zero means that there was a contemporaneous (same month) relationship between the two variables. A lag of one means that an ED presentation in a given month exerted its influence on persons proceeded against for assault during the subsequent month. A lag of two means that an ED presentation in a given month exerted its influence on persons proceeded against for assault two months later, and so on. Findings from analyses of the relationship between alcohol-related ED presentations and persons proceeded against by the police for serious assault are reported in Appendix B.

Analyses were conducted using SAS 9.4 and Stata MP-64 software. The initial approach to the ARIMA modelling was to fit four alcohol-related ED presentation series at lags of zero, one, two and three. Lag terms that were not statistically significant were then removed from the ARIMA model and only the significant lag terms kept. The residuals were then examined using the Ljung-Box test and any autocorrelation was adjusted for using autoregressive or moving average terms (Ljung & Box, 1978). The final fit of the model was assessed using the Akaike Information Criterion (AIC), with smaller values indicating a better fit (Akaike, 1974). Seasonal influences were also assessed using binary terms for specific months of the year (e.g. January) and were included in the final ARIMA model when statistically significant.

Cross-correlations

As a guide to selecting appropriate lags to measure the association between ED presentations and POIs for assault, cross-correlation plots were examined. These are shown in Appendix A. Figure A1 shows the cross-correlations between alcohol-related ED presentations and assault POIs for males and females aged 13-17 years. For males the highest correlations were at lag zero ($r = 0.56$) and lag two ($r = 0.57$). The cross-correlations for females were not as strong, with the highest correlation at lag two ($r = 0.36$). Figure A2 shows the cross-correlations between alcohol-related ED presentations and assault POIs for males and females aged 18-24 years. For females, the highest correlation was at lag zero ($r = 0.53$). For males it was also at lag zero ($r = 0.31$).

Figure A3 shows the cross-correlations between alcohol-related ED presentations and assault POIs for males and females aged

25-64 years. For females the highest correlation was at lag zero (r = 0.82). For males it was also at lag zero (r = 0.73). A notable feature of this cross-correlation plot is how much larger the highest correlation was for the 25-64 year olds compared with the younger age groups. The other notable feature is the seasonal effect with high correlations at positive and negative lag 12.

RESULTS

PERSONS AGED 13-17 YEARS

Figure 1 shows trends in persons proceeded against for assault and alcohol-related ED presentations among males aged 13-17 years. Both POIs for assault and alcohol-related ED presentations increased between 2004 and 2009 and then declined.

Table 1 shows the result of the ARIMA model which predicted the number of males aged 13-17 years proceeded against for assault during 2004 to 2016. Statistically significant estimates were found for alcohol-related ED presentations at lags of zero and two. These show that, when alcohol-related ED presentations among males aged 13-17 increased by 10, the number proceeded against for assault increased by 4.1 during the same month and by 4.5 two months later. The ARIMA model in Table 1 also revealed seasonal effects, with a higher number of male POIs aged 13-17 years proceeded against for assault in March and a lower number in April.[4] The Ljung-Box test of the residuals found that remaining autocorrelations lags were not significantly different from zero (χ^2_{21} = 14.89, p = .829). The number of persons proceeded against for use/possess amphetamines during the same month did not significantly predict the number of persons proceeded against for assault and was not included in Table 1.[5, 6]

Figure 2 shows trends in persons proceeded against for assault and alcohol-related ED presentations among females aged 13-17 years. Assault POIs increased until 2011 and then declined and ED presentations increased until 2009 and then declined. Table 2 shows the result of the ARIMA model which predicted the number of females aged 13-17 years proceeded

Figure 1. Trends in persons proceeded against by NSW police for assault and alcohol-related ED presentations: Males 13-17 years

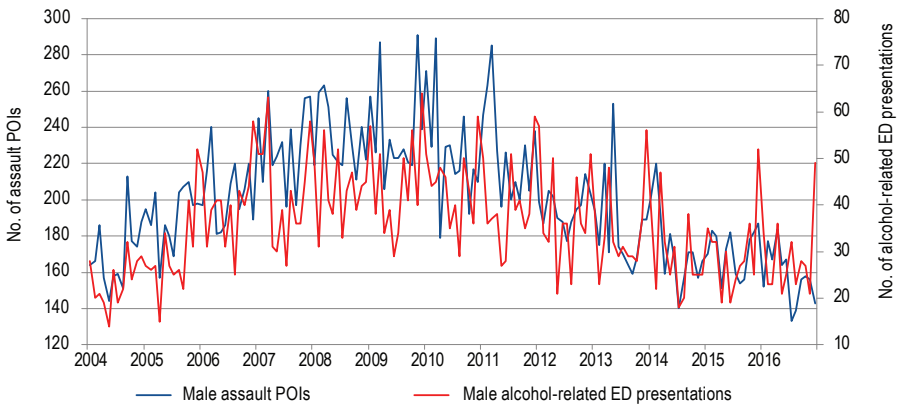


Table 1. Relationship between persons of interest (POIs) proceeded against for assault and alcohol-related ED presentations: Males aged 13-17 years#

Variable	Estimate	Standard Error	*t* value	*p* value
Constant	1.239	0.626	1.98	= .048 *
Alcohol ED presentations (lag 0)	0.410	0.169	2.43	= .015 *
Alcohol ED presentations (lag 2)	0.450	0.173	2.60	= .009 **
March	18.773	5.763	3.26	= .001 **
April	-35.019	6.333	-5.53	< .001 ***
Autoregressive (lag 1)	-0.915	0.046	-20.06	< .001 ***
Moving average (lag 2)	0.728	0.081	9.03	< .001 ***
Moving average (lag 19)	-0.202	0.061	-3.28	= .001 **

AIC = 1343.23; Ljung-Box test: χ^2_{21} = 14.89, p = .829

\# POIs assault and alcohol-related ED presentations series were differenced once

* p < .05, ** p < .01, *** p < .001

Figure 2. Trends in persons proceeded against by NSW police for assault and alcohol-related ED presentations: Females 13-17 years

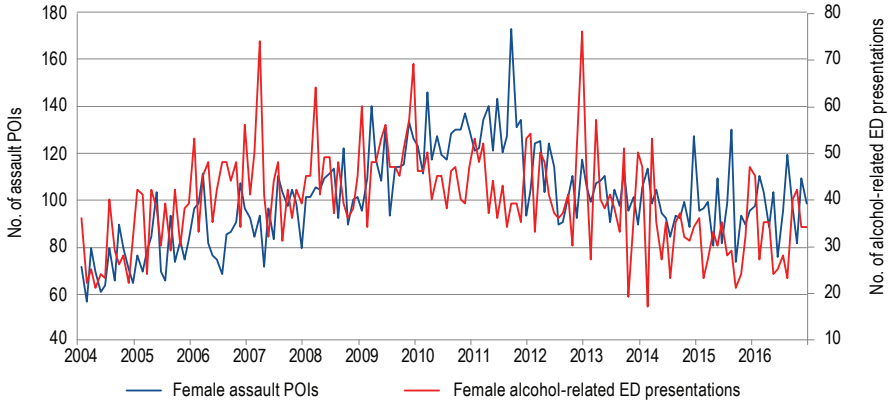


Table 2. Relationship between persons of interest (POIs) proceeded against for assault and alcohol-related ED presentations: Females aged 13-17 years#

Variable	Estimate	Standard Error	*t* value	*p* value
Constant	-0.649	0.650	-1.00	= .319
Alcohol ED presentations (lag 1)	0.174	0.117	1.49	= .137
March	12.618	4.265	2.96	= .003 **
April	-9.908	3.816	-2.60	= .009 **
August	7.604	3.724	2.04	= .041 *
Autoregressive (lag 1)	-0.770	0.066	-11.63	< .001 ***
Moving average (lag 2)	0.621	0.081	7.68	< .001 ***
Moving average (lag 18)	-0.157	0.069	-2.27	= .023 *

AIC = 1232.44; Ljung-Box test: χ^2_{21} = 18.20, p = .637

\# POIs assault and alcohol-related ED presentations series were differenced once

* p < .05, ** p < .01, *** p < .001

Figure 3. Trends in persons proceeded against by NSW police for assault and alcohol-related ED presentations: Males 18-24 years

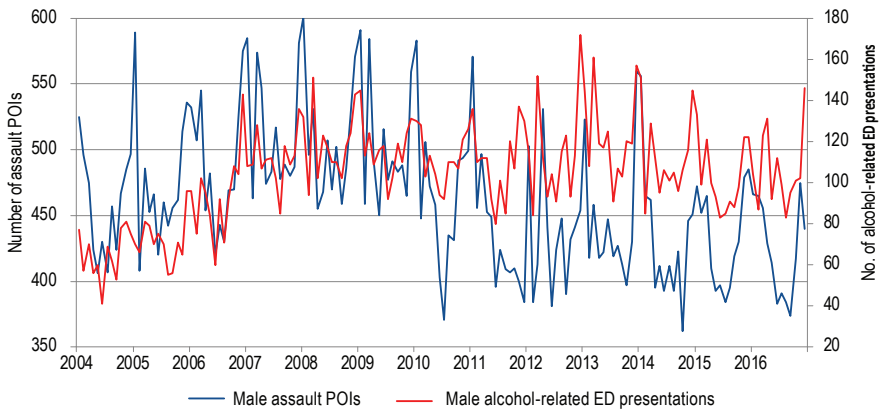


Table 3. Relationship between persons of interest (POIs) proceeded against for assault and alcohol-related ED presentations: Males aged 18-24 years#

Variable	Estimate	Standard Error	*t* value	*p* value
Constant	4.413	1.281	3.44	< .001 ***
Alcohol ED presentations (lag 0)	0.589	0.169	3.48	< .001 ***
Alcohol ED presentations (lag 1)	0.817	0.171	4.79	< .001 ***
January	31.471	10.836	2.90	= .004 **
February	-70.841	10.184	-6.96	< .001 ***
March	39.587	11.698	3.38	< .001 ***
April	-61.648	11.275	-5.47	< .001 ***
Autoregressive (lag 1)	-0.745	0.070	-10.65	< .001 ***
Moving average (lag 2)	0.690	0.080	8.64	< .001 ***
Moving average (lag 8)	0.137	0.068	2.02	= .043 *

AIC = 1510.67; Ljung-Box test: χ^2_{21} = 17.64, p = .672

\# POIs assault and alcohol-related ED presentations series were differenced once

* p < .05, ** p < .01, *** p < .001

against for assault between 2004 and 2016. The strongest relationship between alcohol-related ED presentations and persons proceeded against for assault occurred at a lag of one month but the effect was not statistically significant (b = 0.174, p = .137). Seasonal effects included more females aged 13-17 years being proceeded against for assault in March and August and fewer in April.[7] The Ljung-Box test of the residuals found that remaining autocorrelation lags were not significantly different from zero (χ^2_{21} = 18.20, p = .637). The number of persons proceeded against for use/possess amphetamines during the same month did not significantly predict the number of persons proceeded against for assault and was not included in Table 2.[8, 9]

PERSONS AGED 18-24 YEARS

Figure 3 shows trends in persons proceeded against for assault and alcohol-related ED presentations among males aged 18-24 years. In each series there was a large increase until 2009 after which there was a large decline for assault POIs and a smaller decline for alcohol-related ED presentations. Table 3 shows the ARIMA model for males aged 18-24 years proceeded against for an assault. Statistically significant estimates were found for ED presentations at lags of zero and one. These show that, when alcohol-related ED presentations among males aged 18-24 years increased by 10, there were 5.9 more assault POIs proceeded against during the same month and 8.2 more during the next month. The ARIMA model in Table 3 also revealed seasonal effects; with higher numbers of males aged 18-24 years proceeded against for assault during January and March and lower numbers during February and April.[10] The Ljung-Box test of the residuals found that remaining autocorrelation lags were not significantly different from zero (χ^2_{21} = 17.64, p = .672). Once again, the number of persons proceeded against for use/possess amphetamines during the same month did not significantly predict the number of persons proceeded against for assault.[11, 12]

Figure 4 shows trends in persons proceeded against for assault and alcohol-

Figure 4. Trends in persons proceeded against by NSW police for assault and alcohol-related ED presentations: Females 18-24 years

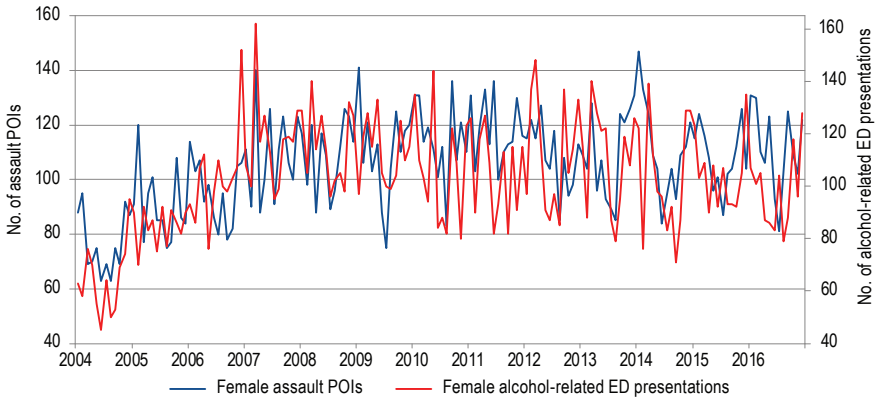


Table 4. Relationship between persons of interest (POIs) proceeded against for assault and alcohol-related ED presentations: Females aged 18-24 years#

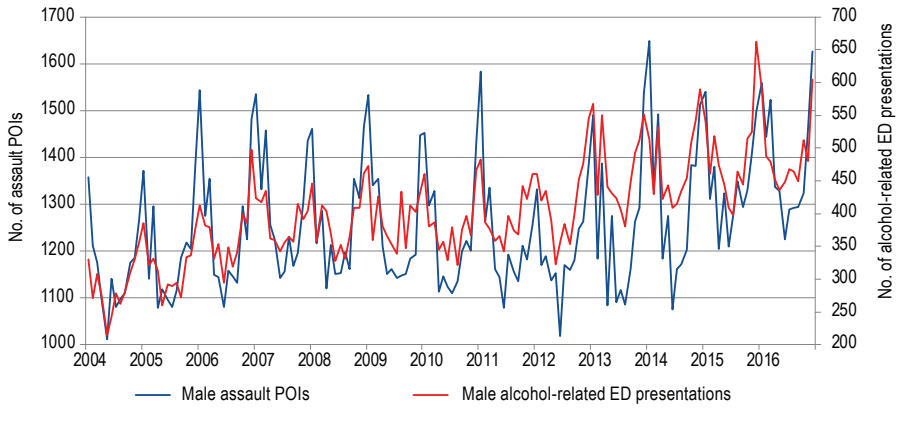
Variable	Estimate	Standard Error	*t* value	*p* value
Constant	-3.512	0.497	-7.07	< .001 ***
Alcohol ED presentations (lag 0)	0.147	0.059	2.49	= .013 *
January	14.363	3.212	4.47	< .001 ***
September	20.167	3.255	6.20	< .001 ***
November	9.859	3.304	2.98	= .003 **
Autoregressive (lag 1)	-0.933	0.066	-14.25	< .001 ***
Moving average (lag 2)	0.735	0.072	10.26	< .001 ***
Autoregressive (lag 3)	0.178	0.058	3.06	= .002 **

AIC = 1219.80; Ljung-Box test: χ^2_{21} = 15.99, p = .770

\# POIs assault and alcohol-related ED presentations series were differenced once

* p < .05, ** p < .01, *** p < .001

Figure 5. Trends in persons proceeded against by NSW police for assault and alcohol-related ED presentations: Males 25-64 years



related ED presentations among females aged 18-24 years. There was an initial increase until 2007 after which both the trend for ED presentations and assault POIs remained relatively flat. The trend lines for persons proceeded against for assault and alcohol-related ED presentations overlap for females aged 18-24 years.

Table 4 shows the ARIMA model predicting the number of females aged 18-24 years proceeded against for assault. A statistically significant estimate was found for ED presentations at a lag of zero, although the effect size was small. When the number of alcohol-related ED presentations among females aged 18-24 years increased by 10 there was an extra 1.5 female assault POIs proceeded against during the same month. Seasonal effects were also found, with higher numbers of females aged 18-24 years proceeded against for assault during January, September and November.[13] The Ljung-Box test of the residuals found that remaining autocorrelation lags were not significantly different from zero (χ^2_{21} = 15.99, p = .770). Including the number of persons proceeded against for use/possess amphetamines during the same month did not significantly predict the number of persons proceeded against for assault.[14, 15]

Persons aged 25-64 years

Figure 5 shows trends in persons proceeded against for assault and alcohol-related ED presentations among males aged 25-64 years. The trends for both variables follow each other closely; rising between 2004 and 2009, falling slightly between 2009 and 2012 and then rising again between 2012 and 2016.

Table 5 shows the result of the ARIMA model which predicted the number of males aged 25-64 years proceeded against for assault. There was a significant positive estimate for alcohol-related ED presentations at a lag of zero. This showed that, when the number of alcohol-related ED presentations among males aged 25-64 years increased by 10, there was

Table 5. Relationship between persons of interest (POIs) proceeded against for assault and alcohol-related ED presentations: Males aged 25-64 years#

Variable	Estimate	Standard Error	*t* value	*p* value
Constant	25.519	4.320	5.91	< .001 ***
Alcohol ED presentations (lag 0)	0.543	0.139	3.91	< .001 ***
POIs use/possess amphetamines (lag 0)	0.532	0.216	2.47	= .014 *
January	43.801	18.478	2.37	= .018 *
February	-186.716	20.226	-9.23	< .001 ***
April	-175.624	9.175	-9.16	< .001 ***
June	-83.947	17.234	-4.87	< .001 ***
December	95.574	18.411	5.19	< .001 ***
Autoregressive (lag 1)	-0.724	0.072	-10.03	< .001 ***
Moving average (lag 2)	0.387	0.095	4.08	< .001 ***
Autoregressive (lag 4)	-0.214	0.078	-2.74	= .006 **
Moving average (lag 5)	0.324	0.095	3.40	< .001 ***

AIC = 1672.59; Ljung-Box test: χ^2_{20} = 25.62, p = .179

\# POIs assault and alcohol-related ED presentations and POIs use/possess amphetamines series were differenced once

* p < .05, ** p < .01, *** p < .001

Figure 6. Trends in persons proceeded against by NSW police for assault and alcohol-related ED presentations: Females 25-64 years

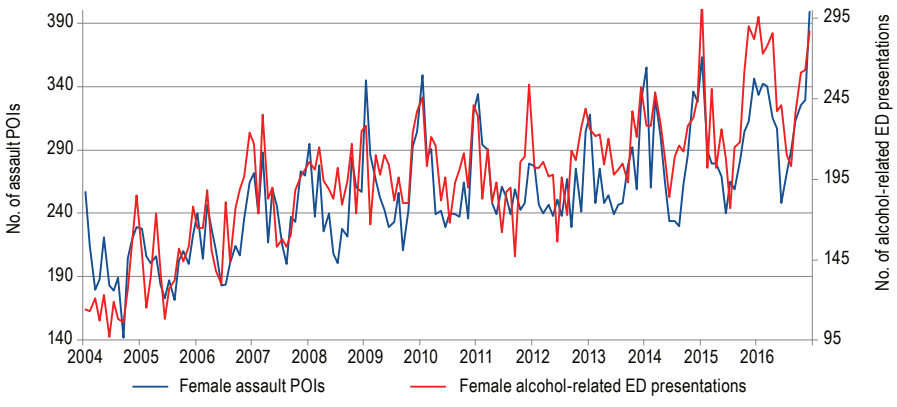


Table 6. Relationship between persons of interest (POIs) proceeded against for assault and alcohol-related ED presentations: Females aged 25-64 years#

Variable	Estimate	Standard Error	*t* value	*p* value
Constant	6.367	1.407	4.52	< .001 ***
Alcohol ED presentations (lag 0)	0.242	0.089	2.73	= .006 **
Alcohol ED presentations (lag 1)	0.184	0.078	2.36	= .018 *
February	-37.202	6.913	-5.38	< .001 ***
April	-29.673	6.259	-4.74	< .001 ***
June	-24.884	7.480	-3.33	< .001 ***
December	20.702	7.014	2.95	= .003 **
Autoregressive (lag 1)	-0.879	0.057	-15.44	< .001 ***
Moving average (lag 2)	0.795	0.077	10.40	< .001 ***

AIC = 1373.68; Ljung-Box test: χ^2_{22} = 18.23, p = .692

\# POIs assault and alcohol-related ED presentations series were differenced once

* p < .05, ** p < .01, *** p < .001

a 5.4 increase in the number of assault POIs proceeded against during the same month. Interestingly, the ARIMA model also revealed a significant positive contemporaneous relationship between the number of males aged 25-64 years proceeded against for use/possess amphetamines and the number proceeded against for assault during the same month. Seasonal effects were also observed with higher numbers proceeded against during January and December and lower numbers during February, April and June.[16] The Ljung-Box test of the residuals found that remaining autocorrelation lags were not significantly different from zero (χ^2_{20} = 25.62, p = .179).[17]

Figure 6 shows trends in persons proceeded against for assault and alcohol-related ED presentations among females aged 25-64 years. These trend lines again overlap showing a consistent increase in ED presentations and persons proceeded against for assault from 2004 to 2009, followed by a plateau until 2013 and then another increase from 2013 to 2016.

Table 6 shows the ARIMA model which predicted the number of females aged 25-64 years proceeded against for assault. Statistically significant estimates were found for alcohol-related ED presentations at lags of both zero and one. When the number of alcohol-related ED presentations among females aged 25-64 increased by 10 there was a 2.4 increase in the number of assault POIs for this group during the same month and a 1.8 increase during the next month. The ARIMA model in Table 6 also revealed seasonal effects with lower numbers of females aged 25-64 years during February, April and June and higher numbers during December.[18] The Ljung-Box test of the residuals found that remaining autocorrelation lags were not significantly different from zero (χ^2_{22} = 18.23, p = .692). Including the number of females aged 25-64 who were proceeded against for use/possess amphetamines during the same month did not significantly predict the number proceeded against for assault.[19, 20]

DISCUSSION

This time series investigation used alcohol-related emergency department (ED) presentation data and NSW police data about persons of interest (POIs) who were proceeded against for assault. Monthly data was used from 2004 through 2016. There were two main research questions. The first was to determine whether the number of persons proceeded against by police for assault increased with the number of alcohol-related presentations to emergency departments (EDs). Overall the answer to this question is 'yes'. An additional finding in relation to this question was that sometimes a change in alcohol-related ED presentations was associated with a change in persons proceeded against for assault one or two months later.

The second question was whether the relationship between alcohol-related ED presentations and persons proceeded against for assault differed by both age group and gender. Among males aged 13-17 years it was found that an increase in the number of alcohol-related ED presentations by 10 was significantly associated with 4.1 additional assault POIs during the same month and 4.5 more two months later. The decline in alcohol-related ED presentations for 13-17 year old males since 2009 predicted the decline in persons who were proceeded against for assault among this age/gender group. For 18-24 year old males, an increase in the number of alcohol-related ED presentations by 10 was significantly associated with an increase in assault POIs proceeded against by 5.9 during the same month and an increase of 8.2 during the next month. This stronger relationship for 18-24 year old males was not surprising given that rates of alcohol use are higher for this group compared with 13-17 year old males (Australian Institute of Health and Welfare, 2017; White & Williams, 2016). Among males aged 25-64 years, 10 additional alcohol-related ED presentations were associated with a contemporaneous increase of 5.4 additional assault POIs.

The relationship between alcohol-related ED presentations and persons proceeded against for assault was much smaller for females compared with males. While no relationship was found for females aged 13-17 years, significant effects were found for the two older age groups. Among females aged 18-24 years an increase in the number of alcohol-related ED presentations by 10 was associated with persons proceeded against for assault increasing by 1.5 during the same month. For females aged 25-64 years, an increase in the number of alcohol-related ED presentations by 10 was associated with 2.4 more assault POIs during the same month and 1.8 more during the next month. The increase in alcohol-related ED presentations for females aged 25-64 years predicted the increase in persons proceeded against for assault which occurred for this group from 2004-2009 and from 2013-2016. The smaller relationship between alcohol-related ED presentations and assault POIs which was found for females is not surprising given their lower prevalence of risky alcohol consumption compared with males (Australian Institute of Health and Welfare, 2017; White & Williams, 2016). Nevertheless significant associations between alcohol-related ED presentations and persons proceeded against for assaults were still apparent for females aged 18 years and older.

The practical import of these results is that ED presentations for alcohol-related harm provide a potential window into future demand for court and prison resources. The fact that some of the strongest effects are lagged one or two months means that information about ED presentations could give up to two months warning of a surge in demand for court time and even longer for a surge in demand for correctional services. This information is of value not just because it facilitates general capacity planning. Corrective Services NSW (CSNSW) operates a number of correctional programs designed to reduce violent re-offending. Early warning of future increases in the number of assault offenders requiring treatment can help ensure that the resources invested in violence reduction programs are matched to the likely demand. The obvious next step is to see whether there are exogenous factors, other than alcohol, that can be used to predict the arrest rate for offences other than assault. Given the strong relationship between heroin use and property crime, for example, it would be interesting to see whether opioid overdoses are of any value in predicting arrests for property crime.

Of course all research studies have limitations. One limitation of this research is that it only includes around three quarters of the EDs in NSW. A further limitation is that the ED data was based on the alcohol-related flag being routinely recorded. Specific interview-based ED studies of injury patients have found higher alcohol-related percentages. One-third had consumed alcohol in the six hours prior to injury in an inner-Sydney ED, almost 22 per cent had in a Fremantle ED case-control study and almost 17 per cent had in the six EDs located in South Western Sydney (Poynton, Donnelly, Weatherburn, Fulde, & Scott, 2005; McLeod, Stockwell, Stevens, & Phillips, 1999; Williams, Mohsin, Weber, Jalaludin, & Crozier, 2011). In a review of alcohol aetiologic fractions for injuries treated in Australian EDs, Chikritzhs et al. (2011) recommended that dedicated coding staff be employed to enter external causes of injury in recording systems.

Despite these limitations this study has found relationships between alcohol-related ED presentations and the number of persons proceeded against for assault. This was an important finding because most studies have been more concerned with the effect of risky alcohol use on crime rather than with the effect of risky alcohol use on the criminal justice system. The NSW criminal justice system is currently experiencing significant demand pressures. Persons charged with assault currently account for around one in 10 cases coming before the adult criminal courts and about 16 per cent of all adults sentenced to a term of imprisonment.[21] The current study suggests that one way to reduce the demand on the court and prison systems would be to encourage further reductions in the prevalence of risky alcohol use, particularly amongst those aged over 25, whose alcohol consumption has not shown much evidence of decline (Australian Institute of Health and Welfare, 2017).[22]

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NOTES

1 The ASSAD surveys do not measure alcohol consumption by first defining the size of standard drinks. Some caution should be exercised when interpreting these trends over time.

2 Unpublished data from NSW Bureau of Crime Statistics and Research, March 13, 2018.

3 Special data request (data can be obtained on request from the author).

4 The ARIMA model for males aged 13-17 years also contained one significant autoregressive term (lag 1) and two significant moving average terms (lag 2 and lag 19).

5 For males aged 13-17 years the number of POIs for use/possess amphetamines at a lag of zero was not statistically significant (b = 1.025, p = .211). When it was included in the ARIMA model the terms for alcohol-related ED presentations remained statistically significant at lags of zero (b = 0.395, p = .019 *) and two (b = 0.440, p = .011 *).

6 For males aged 13-17 years, time series analyses were also conducted using the number of persons proceeded against for serious assault as the outcome. As shown in Table B1 of Appendix B, alcohol-related ED presentations at lags of zero (p = .013 *) and one (p = .011 *) were both statistically significant. When the number of alcohol-related ED presentations among males aged 13-17 years increased by 10 the number of serious assault POIs increased by 2.4 during the same month and by 2.5 during the next month.

7 The ARIMA model for females aged 13-17 years also contained one significant autoregressive term (lag 1) and two significant moving average terms (lag 2 and lag 18).

8 For females aged 13-17 years the number of POIs for use/possess amphetamines at a lag of zero was not statistically significant (b = -0.380, p = .656). When it was included in the ARIMA model the terms for alcohol-related ED presentations at a lag of one remained not statistically significant (b = 0.173, p = .142).

9 For females aged 13-17 years, time series analyses were also conducted using the number of persons proceeded against for serious assault as the outcome. As shown in Table B2 there was a statistically significant positive relationship between alcohol-related ED presentations and persons proceeded against for serious assault at a lag of one month (p = .022 *). An increase in the number of alcohol-related ED presentations among females aged 13-17 years by 10 predicted an increase in serious assault POIs by 1.4 during the next month.

10 The ARIMA model for males aged 18-24 years also contained one significant autoregressive term (lag 1) and two significant moving average terms (lag 2 and lag 8).

11 For males aged 18-24 years the number of POIs for use/possess amphetamines at a lag of zero was not statistically significant (b = -0.212, p = .476). When it was included in the ARIMA model the terms for alcohol-related ED presentations remained statistically significant at lags of zero (b = 0.596, p < .001 **) and one (b = 0.808, p < .001 ***).

12 For males aged 18-24 years old ARIMA analyses were conducted using the number of persons proceeded against for serious assault as the outcome. As shown in Table B3 of Appendix B, alcohol-related ED presentations at lags of zero (p = .026 *), one (p < .001 ***) and two (p = .004 **) were statistically significant. These show that when the number of alcohol-related-ED presentations among males aged 18-24 years increased by 10 there was an increase in the number of serious assault POIs by 2.2 during the same month, by 4.9 during the next month and by 2.7 POIs two months later.

13 The ARIMA model for females aged 18-24 years also contained two significant autoregressive terms (lag 1 and lag 3) and one significant moving average term (lag 2).

14 For females aged 18-24 years the number of POIs for use/possess amphetamines at a lag of zero was not statistically significant (b = -0.386, p = .090). When it was included in the ARIMA model the term for alcohol-related ED presentations at a lag of zero remained statistically significant (b = 0.149, p = .011 *).

15 ARIMA analyses for females aged 18-24 years of age were conducted using the number of persons proceeded against by police for serious assault as the outcome. As shown in Table B4 of Appendix B, there was no statistically significant relationship between alcohol-related ED presentations at a lag of zero and persons who were proceeded against for serious assault (b = 0.048, p = .135). Longer lags of alcohol-related ED presentations at one month and two months respectively did not show any significant relationship and are not shown in Table B4.

16 The ARIMA model for males aged 25-64 years also contained two significant autoregressive terms (lag 1 and lag 4) and two significant moving average terms (lag 2 and lag 5).

17 Analyses were also conducted for males aged 25-64 years using the number of persons proceeded against for serious assault as the outcome. As shown in Table B5 of Appendix B alcohol-related ED presentations at lags of zero (p = .011 *) and two months (p = .047 *) were each significantly predictive of the number serious assault POIs. An increase in the number of alcohol-related-ED presentations among males aged 25-64 by 10 was associated with 1.9 more serious assault POIs during the same month and 1.5 more two months later. Unlike total assaults there was no relationship between trends in the number of persons proceeded against for use/possess amphetamines and serious assault for males aged 25-64 years (p = .252).

18 The ARIMA model for females aged 25-64 years also contained one significant autoregressive term (lag 1) and one significant moving average term (lag 2).

19 For females aged 25-64 years the number of POIs for use/possess amphetamines at a lag of zero was not statistically significant (b = -0.099, p = .632). When it was included in the ARIMA model the terms for alcohol-related ED presentations remained statistically significant at lags of zero (b = 0.250, p = .006 **) and one (b = 0.178, p = .025 *).

20 Analyses were also conducted for females aged 25-64 years with serious assault used as the outcome. As shown in Table B6 of Appendix B alcohol-related ED presentations at lags of zero (p = .004 **) and one month (p = .005 **) were both significantly predictive of the number persons proceeded against for serious assault. As the number of alcohol-related ED presentations among females aged 25-64 increased by 10 the number of persons who were proceeded against by the police for serious assault increased by 1.1 during the same month and by 1.0 during the next month.

21 Unpublished data from NSW Bureau of Crime Statistics and Research, July 23 2018.

22 Improved access to alcohol treatment would also be a useful strategy to reduce the demand on the court and prison systems.

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APPENDIX A

Table A1. Test statistic and p value for augmented Dickey-Fuller unit root tests on all data series: 13-17 year old males and females

Group	Time series	Z(t)	*p* value
Males, 13-17 years old	Assaults POIs	-0.423	= .529
	Assaults POIs, first differenced	-10.748	< .001 ***
	Alcohol ED presentations	-0.579	= .465
	Alcohol ED presentations, first differenced	-16.411	< .001 ***
	Use/possess amphetamines POIs	-6.820 [a.]	< .001 ***
	Use/possess amphetamines POIs, first differenced	-9.218	< .001 ***
	Serious assaults POIs	-0.535	= .483
	Serious assaults POIs, first differenced	-9.272	< .001 ***
Females, 13-17 years old	Assaults POIs	-0.151	= .631
	Assaults POIs, first differenced	-14.953	< .001 ***
	Alcohol ED presentations	-0.554	= .475
	Alcohol ED presentations, first differenced	-12.061	< .001 ***
	Use/possess amphetamines POIs	-8.176 [a.]	< .001 ***
	Use/possess amphetamines POIs, first differenced	-10.093	< .001 ***
	Serious assaults POIs	-0.447	= .519
	Serious assaults POIs, first differenced	-10.006	< .001 ***

a. includes statistically significant deterministic trend term

* $p < .05$, ** $p < .01$, *** $p < .001$

Table A2. Test statistic and p value for augmented Dickey-Fuller unit root tests on all data series: 18-24 year old males and females

Group	Time series	Z(t)	*p* value
Males, 18-24 years old	Assaults POIs	-0.585	= .462
	Assaults POIs, first differenced	-12.298	< .001 ***
	Alcohol ED presentations	-0.118	= .642
	Alcohol ED presentations, first differenced	-14.702	< .001 ***
	Use/possess amphetamines POIs	-2.909 a.	= .163
	Use/possess amphetamines POIs, first differenced	-12.031	< .001 ***
	Serious assaults POIs	-0.646	= .463
	Serious assaults POIs, first differenced	-7.781	< .001 ***
Females, 18-24 years old	Assaults POIs	-0.129	= .638
	Assaults POIs, first differenced	-14.362	< .001 ***
	Alcohol ED presentations	-0.218	= .607
	Alcohol ED presentations, first differenced	-15.011	< .001 ***
	Use/possess amphetamines POIs	-3.103 a.	= .109
	Use/possess amphetamines POIs, first differenced	-10.132	< .001 ***
	Serious assaults POIs	-0.428	= .527
	Serious assaults POIs, first differenced	-13.780	< .001 ***

a. includes statistically significant deterministic trend term
* $p < .05$, ** $p < .01$, *** $p < .001$

Table A3. Test statistic and p value for augmented Dickey-Fuller unit root tests on all data series: 25-64 year old males and females

Group	Time series	Z(t)	*p* value
Males, 25-64 years old	Assaults POIs	-7.980 a.	< .001 ***
	Assaults POIs, first differenced	-8.386	< .001 ***
	Alcohol ED presentations	-5.027 a.	< .001 ***
	Alcohol ED presentations, first differenced	-17.303	< .001 ***
	Use/possess amphetamines POIs	-2.194 a. b.	= .490
	Use/possess amphetamines POIs, first differenced	-19.803 b.	< .001 ***
	Serious assaults POIs	-6.864 a.	< .001 ***
	Serious assaults POIs, first differenced	-7.352	< .001 ***
Females, 25-64 years old	Assaults POIs	-5.542 a.	< .001 ***
	Assaults POIs, first differenced	-17.243	< .001 ***
	Alcohol ED presentations	-5.013 a.	< .001 ***
	Alcohol ED presentations, first differenced	-19.621	< .001 ***
	Use/possess amphetamines POIs	-4.022 a. b.	= .008 **
	Use/possess amphetamines POIs, first differenced	-30.797 b.	< .001 ***
	Serious assaults POIs	-6.211 a.	< .001 ***
	Serious assaults POIs, first differenced	-11.902	< .001 ***

a. includes statistically significant deterministic trend term
b. estimated using Phillips-Perron test
* $p < .05$, ** $p < .01$, *** $p < .001$

Figure A1. Cross-correlation between alcohol-related ED presentations and POIs for assault: 13-17 year olds

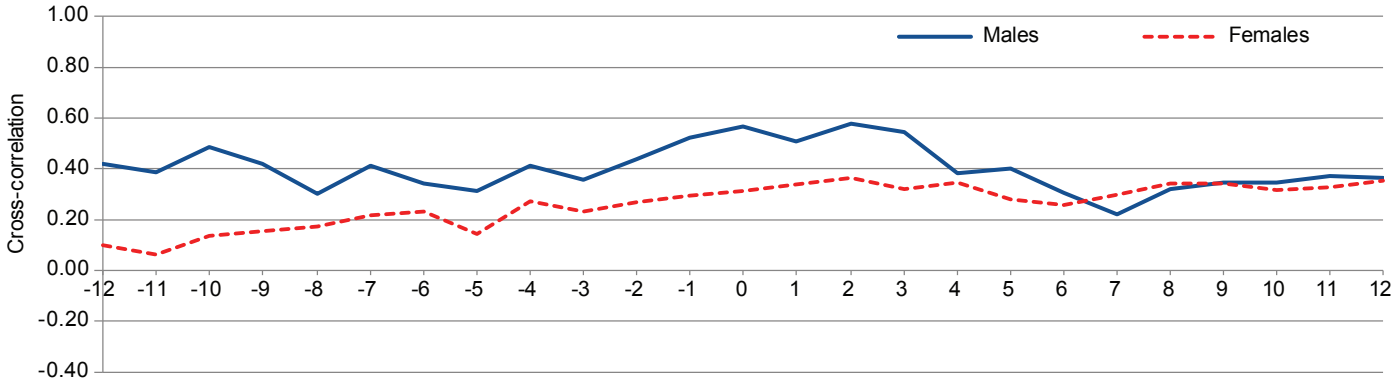


Figure A2. Cross-correlation between alcohol-related ED presentations and POIs for assault: 18-24 year olds

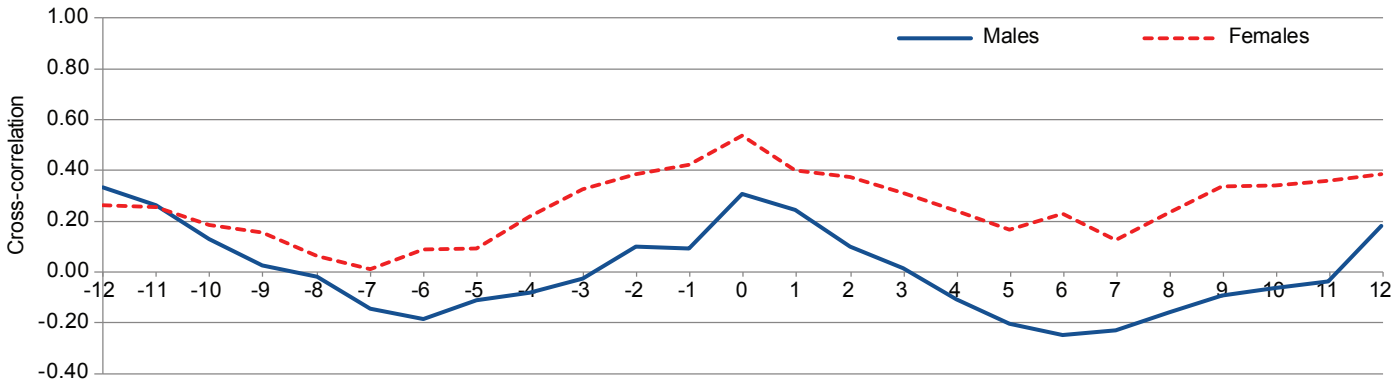


Figure A3. Cross-correlation between alcohol-related ED presentations and POIs for assault: 25-64 year olds

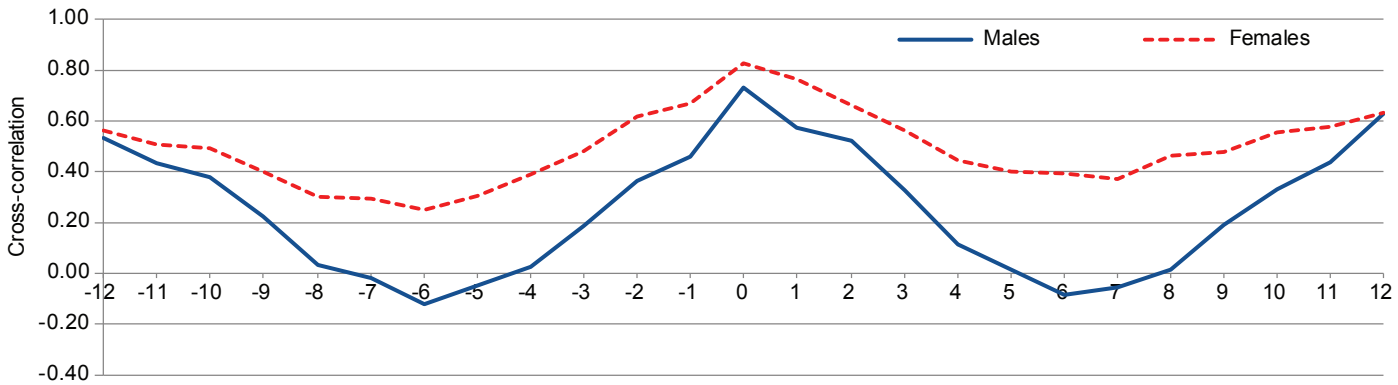


Figure A4 shows the cross-correlations for 13-17 year old alcohol-related ED presentations and persons proceeded against for serious assault for males and females. For males the highest correlations were at lag zero (r = 0.55) and lag one (r = 0.52). For females the highest was at lag one (r = 0.43).

Figure A5 shows the cross-correlations among 18-24 year olds between alcohol-related ED presentations and persons proceeded against for serious assault for males and females. For females the highest correlation was at lag zero (r = 0.47). For males it was also at lag zero (r = 0.38).

Figure A6 shows the cross-correlations among 25-64 year olds between alcohol-related ED presentations and persons proceeded against for serious assault for males and females. For females the highest correlation was at lag zero (r = 0.77). For males it was also at lag zero (r = 0.72).

Figure A4. Cross-correlation between alcohol-related ED presentations and POIs for serious assault: 13-17 year olds

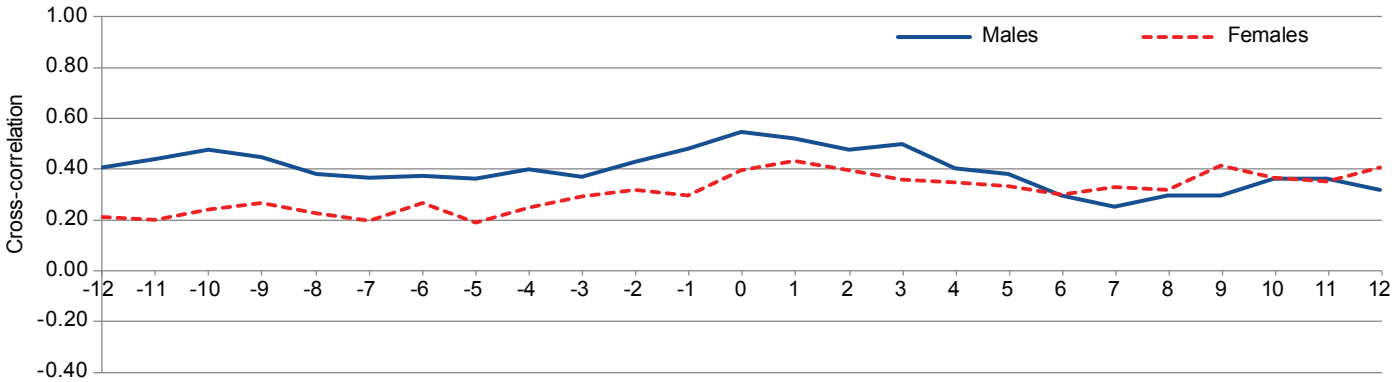


Figure A5. Cross-correlation between alcohol-related ED presentations and POIs for serious assault: 18-24 year olds

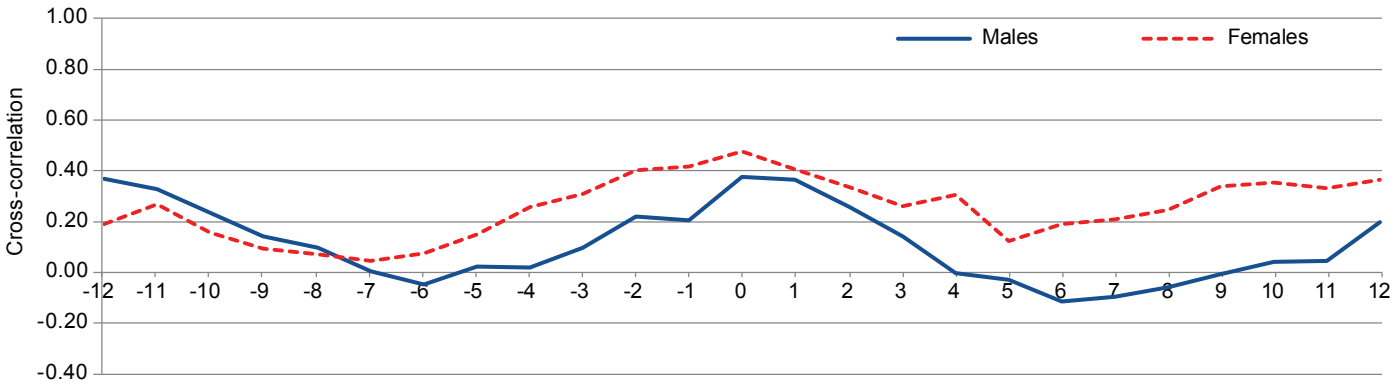
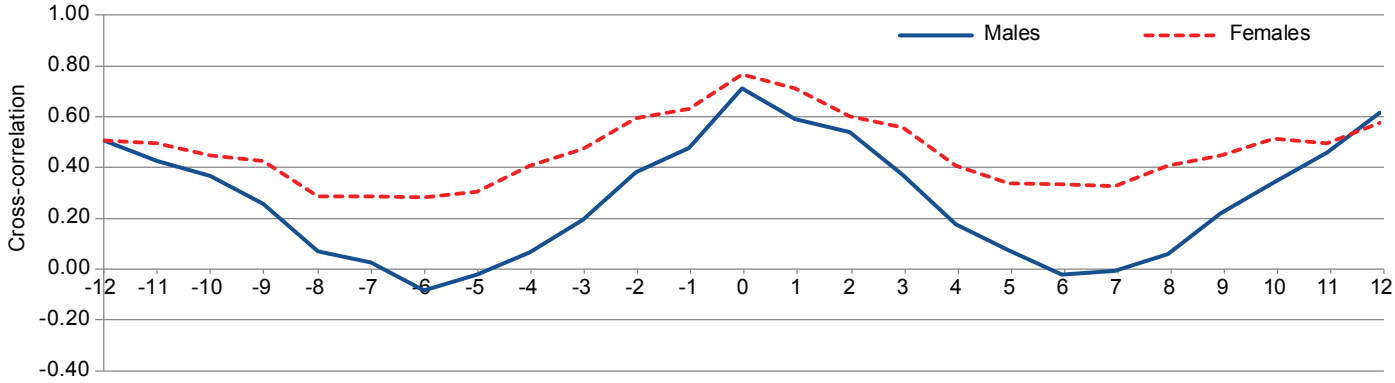


Figure A6. Cross-correlation between alcohol-related ED presentations and POIs for serious assault: 25-64 year olds



APPENDIX B

Table B1. Relationship between persons of interest (POIs) proceeded against for serious assault and alcohol-related ED presentations: Males aged 13-17 years#

Variable	Estimate	Standard Error	*t* value	*p* value
Constant	0.277	0.371	0.75	= .455
Alcohol ED presentations (lag 0)	0.240	0.096	2.49	= .013 *
Alcohol ED presentations (lag 1)	0.247	0.098	2.53	= .011 *
March	9.911	3.401	2.91	= .004 **
April	-14.659	3.364	-4.36	< .001 ***
Autoregressive (lag 1)	-0.860	0.055	-15.60	< .001 ***
Moving average (lag 2)	0.645	0.086	7.51	< .001 ***
Moving average (lag 6)	-0.126	0.071	-1.76	= .078

AIC = 1183.63; Ljung-Box test: χ^2_{21} = 16.26, p = .755

\# POIs assault and alcohol-related ED presentations series were differenced once

* p < .05, ** p < .01, *** p < .001

Table B2. Relationship between persons of interest (POIs) proceeded against for serious assault and alcohol-related ED presentations: Females aged 13-17 years#

Variable	Estimate	Standard Error	*t* value	*p* value
Constant	0.099	0.197	0.50	= .615
Alcohol ED presentations (lag 1)	0.135	0.059	2.30	= .022 *
March	3.498	2.043	1.71	= .087
April	-4.477	1.998	-2.24	= .025 *
Autoregressive (lag 1)	-0.790	0.065	-12.24	< .001 ***
Moving average (lag 2)	0.644	0.081	7.93	< .001 ***

AIC = 1019.21; Ljung-Box test: χ^2_{22} = 18.86, p = .654

\# POIs assault and alcohol-related ED presentations series were differenced once

* p < .05, ** p < .01, *** p < .001

Table B3. Relationship between persons of interest (POIs) proceeded against for serious assault and alcohol-related ED presentations: Males aged 18-24 years#

Variable	Estimate	Standard Error	*t* value	*p* value
Constant	2.513	0.621	4.05	< .001 ***
Alcohol ED presentations (lag 0)	0.215	0.096	2.23	= .026 *
Alcohol ED presentations (lag 1)	0.491	0.088	5.60	< .001 ***
Alcohol ED presentations (lag 2)	0.272	0.095	2.87	= .004 **
February	-25.742	7.330	-3.51	< .001 ***
March	16.537	7.781	2.13	= .034 *
April	-25.392	6.672	-3.81	< .001 ***
Autoregressive (lag 1)	-0.903	0.049	-18.34	< .001 ***
Moving average (lag 2)	0.787	0.071	11.07	< .001 ***

AIC = 1321.36; Ljung-Box test: χ^2_{22} = 20.37, p = .560

\# POIs assault and alcohol-related ED presentations series were differenced once

* p < .05, ** p < .01, *** p < .001

Table B4. Relationship between persons of interest (POIs) proceeded against for serious assault and alcohol-related ED presentations: Females aged 18-24 years#

Variable	Estimate	Standard Error	*t* value	*p* value
Constant	-1.346	0.287	-4.68	< .001 ***
Alcohol ED presentations (lag 0)	0.048	0.032	1.49	= .135
January	3.905	1.930	2.02	= .043 *
September	8.244	1.941	4.25	< .001 ***
November	4.865	1.897	2.56	= .010 *
Autoregressive (lag 1)	-0.887	0.052	-17.17	< .001 ***
Moving average (lag 2)	0.757	0.074	10.21	< .001 ***

AIC = 1035.75; Ljung-Box test: χ^2_{22} = 18.40, p = .682

POIs assault and alcohol-related ED presentations series were differenced once

* p < .05, ** p < .01, *** p < .001

Table B5. Relationship between persons of interest (POIs) proceeded against for serious assault and alcohol-related ED presentations: Males aged 25-64 years#

Variable	Estimate	Standard Error	*t* value	*p* value
Constant	5.127	1.522	3.37	< .001 ***
Alcohol ED presentations (lag 0)	0.187	0.074	2.54	= .011 *
Alcohol ED presentations (lag 2)	0.154	0.077	1.99	= .047 *
February	-61.839	11.774	-5.25	< .001 ***
April	-51.278	10.583	-4.85	< .001 ***
December	54.912	10.823	5.07	< .001 ***
Autoregressive (lag 1)	-0.890	0.050	-17.68	< .001 ***
Moving average (lag 2)	0.712	0.078	9.09	< .001 ***

AIC = 1474.51; Ljung-Box test: χ^2_{22} = 14.75, p = .873

POIs assault and alcohol-related ED presentations series were differenced once

* p < .05, ** p < .01, *** p < .001

Table B6. Relationship between persons of interest (POIs) proceeded against for serious assault and alcohol-related ED presentations: Females aged 25-64 years#

Variable	Estimate	Standard Error	*t* value	*p* value
Constant	1.512	0.419	3.60	< .001 ***
Alcohol ED presentations (lag 0)	0.114	0.040	2.86	= .004 **
Alcohol ED presentations (lag 1)	0.104	0.037	2.82	= .005 **
February	-9.837	3.196	-3.08	= .002 **
April	-14.809	3.155	-4.69	< .001 ***
December	7.751	3.417	2.27	= .023 *
Autoregressive (lag 1)	-0.865	0.052	-16.68	< .001 ***
Moving average (lag 2)	0.891	0.049	18.15	< .001 ***

AIC = 1161.10; Ljung-Box test: χ^2_{22} = 14.39, p = .887

POIs assault and alcohol-related ED presentations series were differenced once

* p < .05, ** p < .01, *** p < .001

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