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Abstract

This paper explores the relation between season (fall, winter, spring and summer) and drug use among arrestees. The analysis examines seasonal differences of proportions of drug tests positive for marijuana or cocaine among recently arrested and booked suspects in Anchorage, Alaska. The study is based on ADAM data collected in Anchorage during the period between 1999 and the third quarter of 2003.

Season effects on a wide range of phenomena have been studied for centuries. Virtually from the beginning of human time, human kind have been concerned with seasons and have structured their behavior to meet the demands of seasons.[1] From earliest times where humans lived and roamed, and what they ate was dictated by season. In light of the primordial importance of seasons it is not surprising that seasonal effects have been explored by the scientific community on a wide range of human activity. Volumes have been written on seasonal effects on labor markets, economies, recreation, mood, health, and more recently on criminal behavior. However, seasonal studies of drug use have not received a great deal of attention. This study explores this neglected area of inquiry by examining seasonal patterns of cocaine and marijuana use among a particular population—adult arrestees.

The study begins with a brief discussion of the styles of seasonal studies and a review of the modest seasonal drug use literature. This is followed by a statement of the research question, a discussion of the data, presentation of findings, and an offering of conclusions.

Styles of Seasonal Studies

Season studies tend to take on two principal forms. First are those studies that treat seasonal variation as an irritant to the analysis. These studies, typically trend studies, examine seasonal effects as the analyst tries to understand trends and predict the future (e.g., Rhodes, 2003; Funk and Kugler, 2000; Gorr and Olligschlaeger, 2002; Kim and Skogan, 2003; Bowers and Johnson, 2003) or they explore the biases associated with data collection during different parts of the year (e.g., Lemmens and Knibbe, 1993; Cho, Johnson and Fendrich, 2001; Huang, Schildhaus and Wright, 1999). In both cases the interest in seasonal effects is to isolate them so that the analyst can statistically control their effect on estimates or nuance inferences based on known biases.

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[1] See Hawley, 1950 for an elegant discussion of human adaptations to seasonal cycles, particularly pp. 292-95.

Second, are those that treat season effects as interesting and in need of explanation. In the recent criminology and criminal justice literature seasonal effects have been viewed primarily through the lens of routine activities theory (e.g., Cohn and Rotton, 2000; Rotton and Cohn, 2001; Yan, 2004).[2] The essential routine activities argument is that seasons effect crime incidence because seasons effect the patterns of routine activities. This line of reasoning suggests that summer peaks for "minor personal larceny" are a function of school summer vacations (Bureau of Justice Statistics, 1980); that shoplifting peaks in winter are a function of heavier clothing worn during this season (Yan, 2004); or summer peaks in property crime are explained by increased out of home activity that make persons more vulnerable to meeting motivated offenders (personal larceny and robbery) and residences more vulnerable for lack of guardianship (burglary; Cohen and Rotton, 2000).

The present study asks the zero-order question, *Is there a relation between incidence of drug use and season?* While not anticipating the findings or treating seasons as nuisance or as something to explain, the answer to this question is significant. If seasonal effects are observed we will know that data collection that occurs during just one season will be biased[3]; we will know that forecasts of future drug use must incorporate adjustments for season; and, we will know that there is something about seasons that influence drug usage setting the stage for more elaborate explanatory studies. However, if seasonal effects are not observed we can have greater confidence in estimates drawn from short-term data collection efforts and we can continue to explore explanations of drug use without regard for season.

Seasonal Use of Drugs

The search for a literature about seasonality and drug use produced very modest results, just two articles and four government reports, so the scope of the review was extended to include studies of seasonal variation in alcohol use. The extended search (limited to refereed journals) surfaced four additional articles on seasonal use of alcohol.

The alcohol articles, all appearing in the *Journal of Studies on Alcohol*, were concerned either with bias of short-term surveys (Cho, Johnson and Fendrich, 2001; Lemmens and Knibbe, 1993), the relation between alcohol sales and problem drinking (Fitzgerald and Mulford, 1984), or with policy implications for the timing of interventions (Uitenbroek, 1996). All four alcohol studies revealed seasonal patterns to alcohol use. Three of the studies isolate high rates of reported drinking during the December-January

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[2] Studies prior to specification of routine activities theory allude to the effect of weather, amount of daylight, school year and length of month to explain seasonal crime correlates. However, when these effects are discussed they frequently refer to seasonal correlates that effect the rates of convergence in space and time of suitable victims, motivated offenders, and capable guardians (see Bureau of Justice Statistics, 1980, Crime and Seasonality).

[3] This is salient as the National Institute of Justice is considering sweeping changes to the Arrestee Drug Abuse Monitoring data collection program. One of the changes under consideration is once/year data collection rather than quarterly data collection that has characterized most of the ADAM history.

holiday season (Cho, Johnson and Fendrich, 2001; Uitenbroek, 1996; and, Lemmens and Knibbe, 1993)[4]. Three of the studies isolated the peak in rates of episodic heavy drinking (euphemistically called 'partying') in the summer months (Cho, Johnson and Fendrich, 2001; Uiterbroek, 1996; and, Fitzgerald and Mulford, 1984). Only Lemmens and Knibbe (1993) failed to find a secondary summer peak (second to the holiday peak); the off holiday peak in their study was spring (March-May).

These few studies show a remarkable degree of convergence. This is all the more impressive when we consider that they were based on very different populations and spanned different survey methods (six U.S. state telephone survey, Cho, Johnson and Fendrich, 2001; in-person interviews of a Dutch sample, Lemmens and Knibbe, 1993; telephone surveys of Glasgow and Edinburgh, Scotland samples, Uiterbroek, 1996; and, three waves of in-person interviews with an Iowa panel, Fitzgerald and Mulford, 1984). That noted, it is important to note that our conclusion that alcohol use is seasonal remains based on just four studies.

The literature about seasonal use of illicit drugs is less cogent. The literature search surfaced four government reports and two refereed articles that address seasonality of drug use. Two government reports examined seasonal drug use for an array of types of drugs (Drugs and Crime Prevention Committee, 2002; Huang, Schildhaus and Wright, 1999); the two articles examine seasonal use of marijuana (Zingraff and Belyea, 1983; Kovalenko, et al., 2000); and, the two additional government reports describe seasons as correlates of initiation of marijuana use (Gfroerer, Wu and Penne, 2002; Office of Applied Statistics, 2004).

The studies of arrays of drugs were of two types. The first (Huang, Schildhaus and Wright, 1999) examined quarterly estimates of substance use developed from 1992-1996 National Household Survey(s) on Drug Abuse. Huang and colleagues report no evidence of seasonal patterns of adult use of: marijuana, any illicit drug, any illicit drug except marijuana, marijuana only, alcohol, cigarette use, or heavy drinking. However, for teens (12-17 years of age) they found evidence of seasonal use of: any illicit drug except marijuana (higher in winter than in summer or fall); and, alcohol (higher in winter than in spring and fall, and higher in summer than fall). The second of these studies was conducted in Australia using arrest data. The Drugs and Crime Prevention Committee (2002) found evidence of higher arrest rates for drug possession and use during the Australian fall and winter (April through July) and lower rates during the Australian spring (November and December).[5]

The two articles both examined seasonality of marijuana use and use of other illicit drugs. Zingraff and Belyea (1983) examined fluctuations in marijuana arrest rates and found high rates in the summer and low rates in winter. Kovalenko (2000) and colleague's review of clinical interviews found that symptoms

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[4] Fitzgerald and Mulford (1984) did not collect data that spanned the holiday season so were silent on use during that period.

[5] The Drugs and Crime Prevention Committee Report did not distinguish different types of drugs but a recent report by the same committee notes that over 75 percent of those reporting use of illicit drugs reported using marijuana (2004).

of marijuana use were greater in summer months than in winter. Neither of these studies report evidence of seasonal patterns of use of other illicit drugs.

Finally, the last two government reports, both drawing on survey data from the National Survey on Drug Use and Health focused on initiation of marijuana use by recent initiates. Gfroerer, Wu and Penne's (2002) examination of 1999 and 2000 data found that the peak for initiation of marijuana use was during the early summer months. The recently issued report by the Office of Applied Statistics (2004) also found a summer peak for marijuana initiates but noted a bi-modal pattern of initiation for alcohol initiates with peaks in the summer and over the winter holiday period.

The drug use studies do not converge as neatly as the alcohol studies. Evidence for drug use seasonality is found in studies of arrest data and from analysis of data collected during clinical interviews but not in the survey data (except for teen use of illicit drugs other than marijuana). Where evidence of seasonality is found it is not consistent. The Australian study found a fall to winter peak (April-July) for possession and use of any drug, while U.S. studies found summer peaks for marijuana arrests (June or July) or marijuana use symptoms (August-September). No seasonal studies were found that disaggregate the "other drug" use category into types (e.g., cocaine, opiates, methamphetamine) so it is not possible to know if there is evidence of seasonality by drug type. However, when other illicit drugs (other than marijuana) were examined in the aggregate, no evidence of seasonal effect is reported.

Taken together the substance use literature suggests substantial seasonal patterning to alcohol use, modest seasonal effect to marijuana use but no seasonal patterning for cocaine.

Data and Methods of Analysis

The question guiding this research is the basic zero-order seasonality question conditioned by data available for the study—"Does cocaine or marijuana drug use exhibit a seasonal pattern among adult arrestees?" This question is addressed below using Arrestee Drug Abuse Monitoring (ADAM) data collected in Anchorage, Alaska during the period between January 1999 and December 2003. During that period 2,752 recently incarcerated men and women completed the ADAM protocol.[6] That is, they were interviewed about their drug use behavior and provided urine samples that were subsequently tested for the presence of cocaine and marijuana among other drugs. The study will focus on the quarterly proportions of participating arrestees that tested positive for either marijuana or cocaine.

These data are particularly well suited to address the question at hand for several reasons. First, ADAM data collection occurred at quarterly intervals over an extended period of time. This permits the construction of stable seasonal rates of drug presence among arrestees based on urine testing (rather than self-reported use) which has been shown to produce very accurate results (Katz, et al., 1997). Second,

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[6] For a detailed description of the ADAM data collection process see National Institute of Justice, *Arrestee Drug Abuse Monitoring Annual Report*, 2000.

Anchorage is a particularly good location to explore seasonal effects as seasonal variation is extreme. If seasonal imperatives drive drug use, then the effect of season on rates of use would be most apparent where seasonal variation is most extreme.

Though the Anchorage ADAM data are well suited to this analysis there are several caveats that must be acknowledged. These data depict presence of cocaine or marijuana among arrestees who agreed to participate fully in the ADAM interview. Therefore, these findings pertain solely to cooperative arrestees and do not necessarily provide insights into drug use patterns of: non-participating arrestees[7], other populations of marijuana and cocaine users[8], or to users of other drugs. Additionally, in Anchorage, ADAM interviews were limited to adult arrestees so these data provide no information about patterns of use among juveniles.

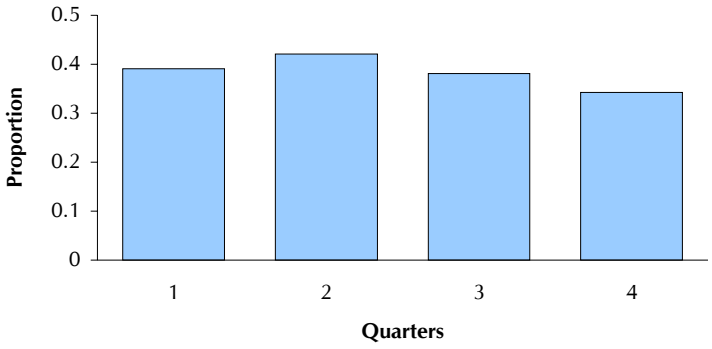
The analysis is completed through testing for differences among quarterly proportions of arrestees testing positive for either marijuana or cocaine[9]. Multiple comparisons among proportions are completed in the case where differences are detected. This combination of tests allows isolation of differences in proportions and permits specification of actual quarterly differences.

Seasonality and Marijuana Use

During the period between 1999 and 2003 slightly less than 39 percent of participating Anchorage arrestees tested positive for marijuana. This proportion ranged from a high of slightly more than 52 percent in the second quarter of 2002 to a low of 29 percent during the fourth quarter of 2000. Figure 1 highlights the aggregated quarterly proportions.

Table 1 presents the tests of difference of the aggregated quarterly proportions of Anchorage arrestees testing positive for marijuana use. These data suggest that at least one quarter's proportion is statistically

Figure 1. Proportion of Anchorage Arrestees Testing Positive for Marijuana, Aggregated by Quarters, 1999-2003



[7] Comparisons of cooperative and non-responsive arrestees in Anchorage suggests that there are no significant demographic or charge differences—see Myrstol, B. and Langworthy, R. (2003).

[8] For a more complete discussion of the range of drug using populations see Rhodes, W. (2003).

[9] See Glass and Hopkins (1984) for discussion of statistical tests for differences in proportions (285-89) and multiple comparisons of proportions (391-92).

different than the others (χ^2=8.405, p<.05) implying a seasonal difference in marijuana use. This finding is consistent with Zingraff and Belyea (1983) and the Drugs and Crime Prevention Committee (2002) analyses of arrest data, and Kovalenko's et al. (2000) analysis of clinical interviews where they found seasonal differences; but, at odds with Huang, Schildhaus and Wright's (1999) analysis of survey data where they found no quarterly differences in reported marijuana use.

Table 1. Proportion of Anchorage Arrestees Testing Positive for Marijuana, Aggregated by Quarters, 1999-2003

	Quarter					
	1	2	3	4		
Testing positive:						
Number	284	304	282	193	n_{pos}	1,063
Proportion	.391	.421	.381	.342	p_{pos}	.386
Testing negative:						
Number	442	418	459	370	n_{neg}	1,689
Proportion	.609	.579	.619	.657	p_{neg}	.614
Quarterly totals	**726**	**722**	**741**	**563**		**2,752**

$\chi^2 = 8.405$, $p < .05$.

Zingraff and Belyea (1983) and Kovalenko, et al. (2000) also concluded that the marijuana arrest rates, or counts of symptoms of marijuana use, peaked during the summer and were lowest during the winter. The Drugs and Crime Prevention Committee reports suggest that drug use and possession[10] arrests peaked in Australian winter months (April- July) and lower during the Australian summer (November-December). Table 2 presents the results of multiple comparisons of proportions to determine which of the contrasting proportions are statistically different. Review of the table shows that the fifth contrast, comparing spring and fall quarters, is the only one to produce a statistical difference in proportions. The proportion of spring quarter arrestees testing positive for marijuana use is statistically higher than the fall quarter; otherwise there are no differences. This finding is marginally at odds with Zingraff and Belyea (1983) and Kovalenko,

Table 2. Comparisons of Seasonal Proportions of Arrestees Testing Positive for Marijuana Use

Contrast	Squared difference	Variance of contrast	χ^2
1. P_1-P_2	.00090	.00067	1.34
2. P_1-P_3	.00010	.00065	0.15
3. P_1-P_4	.00240	.00073	3.29
4. P_2-P_3	.00160	.00066	2.42
5. P_2-P_4	**.00624**	**.00074**	**8.43** *
6. P_3-P_4	.00152	.00072	2.11

* Statistically significant at α<.05

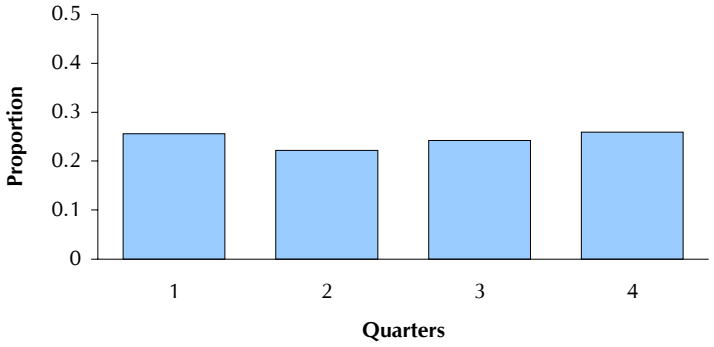
[10] The Committee report concerned any drug and was not focused specifically on marijuana but it seems likely that these statistics were dominated by marijuana charges. A later Drugs and Crime Prevention Committee report notes that over 75 percent of those reporting use of illicit drugs reported using marijuana (2004).

et al. (2000) and quite at odds with the Australian study unless the focus shifts from season to months of the year. If the focus is on months of the year, then the findings here are the same as the Australian finding, higher in the second quarter than in the fourth.

Seasonality and Cocaine Use

During the period between 1999 and 2003 slightly less than 25 percent of participating Anchorage arrestees tested positive for cocaine. This proportion ranged from a high of slightly more than .34 in the fourth quarter of 2003 to a low of .16 during the second quarter of 2001. Figure 2 highlights the aggregated quarterly proportions.

Figure 2. Proportion of Anchorage Arrestees Testing Positive for Cocaine Aggregated by Quarters, 1999-2003



The literature is virtually silent on seasonal cocaine use. The only marginal exception to this conclusion is found in Huang, Schildhaus and Wright (1999) where they found no evidence of seasonal differences in adult use of "any illicit drug except marijuana" and in Zingraff and Belyea's (1983) failure to report seasonal patterns in arrests for "opium, cocaine, and their derivatives".[11] Table 3 presents the tests of difference of

Table 3. Proportion of Anchorage Arrestees Testing Positive for Cocaine, Aggregated by Quarters, 1999-2003

	Quarter					
	1	2	3	4		
Testing positive:						
Number	186	160	179	146	n_{pos}	671
Proportion	.256	.222	.242	.259	p_{pos}	.244
Testing negative:						
Number	540	562	562	417	n_{neg}	2,081
Proportion	.744	.778	.758	.741	p_{neg}	.756
Quarterly totals	**726**	**722**	**741**	**563**		**2,752**

$\chi^2 = 3.163$, $p > .05$.

[11] Zingraff and Belyea (1983) report results of tests for seasonality of "arrests for marijuana" but not for "opium, cocaine, and their derivates". An analysis similar to the one they reported on the marijuana arrest series was completed on the "opium, cocaine, and their derivatives" time series data they presented in Figure 3, p. 473 and it yielded no evidence of seasonal patterns.

the aggregated quarterly proportions of Anchorage arrestees testing positive for cocaine use. These data support the modest literature noted above finding no evidence of seasonal differences in cocaine use among recent Anchorage arrestees.

Discussion

The study began with an interest in extending the sparse literature on the seasonality of drug use. It was noted that in this very sparse literature there is an indication of seasonality in marijuana use (depending upon the data source) but that there was no convergence regarding which seasons were high and low. As attention turned to cocaine use two findings became apparent: 1) there is no literature specifically addressing seasonality of cocaine use; and, 2) when seasonality of opiates, cocaine and other drugs were considered in the aggregate no evidence of seasonal effects was found. This analysis affirms these findings. That is, a modest seasonal effect was found for marijuana (in this case use was highest in the spring compared to the fall) and no seasonal effect was found for cocaine.

For those concerned about the nuisance of seasonality for longitudinal analyses or estimation of prevalence these findings suggest that these concerns are not problematic for cocaine and very modest for marijuana. It seems that analysts interested in forecasting incidence of cocaine use among arrestees can develop their forecasts without regard for seasonal parameters while those developing models to predict marijuana use would be advised to incorporate seasonal elements into their estimate. It also seems likely that data collection in the spring may over-estimate incidence of marijuana use in the arrestee population while collection in the fall may under-estimate.

For those concerned with explanations of seasonality of use these findings suggest that it is necessary to explain seasonal variation for marijuana use and seasonal consistency for cocaine use. Though testing of alternative explanations of these findings is beyond the scope of this inquiry several plausible explanations emerge.

First are biological explanations. Kovalenko et al. (2000) expressly considered biological explanations (brain chemistry) for a wide range of psychological maladies in addition to marijuana use and use of other substances. They concluded that seasonal use of marijuana "…may have a societal rather than a biological explanation…" (116). Their conclusion seems supported by these data for several reasons. First, of the six contrasts just one demonstrated a difference, spring peak and autumn low, suggesting that seasons are more alike than different. Second, the seasonal difference detected is between seasons that are the least different—one would expect biological determinants to appear between extreme differences of seasons. Finally, when these findings are coupled with the Australian study we see that the peaks and lows are registered for the same months but that these months represent opposite seasons in northern and southern hemispheres. On balance there seems little reasonable support for a biological thesis governing seasonal use of marijuana.

Second are supply explanations of seasonality—it may be that marijuana is marginally more available in the spring than in the fall. Huang, Schildhaus and Wright (1999) explored the relation between availability of marijuana and reported use among school children and found a positive relation between availability and use. They also noted a seasonal pattern to availability (though not sufficient to produce seasonality of use) with availability lower in summer relative to spring and fall. Also, Zingraff and Belyea (1983) reason that if supply drives use (resulting in higher arrest rates) then a peak should appear in the fall after harvest which was contrary to their findings (and ours). While Huang and her colleagues observations are compelling, their findings pertain to school children and they attribute the season pattern of availability to school attendance. For supply to explain the seasonal pattern observed here it would be necessary to demonstrate seasonal variation in the supply of marijuana and a constant supply of cocaine.

A third family of explanations are those about seasonal structuring of routine activities of: criminals who get arrested, drug users, or justice system actors (primarily police and parole/probation officers). This explanation suggests that the observed seasonal pattern of marijuana use is spuriously related to other seasonal activities. Indeed, Zingraff and Belyea (1983) suggest such an explanation when they account for the summer arrest peak in marijuana arrests they observed. They note, "It is more likely that the high rates in the summer months are due to higher visibility of users. This interpretation would be in line with the argument that police behavior is more reactive than proactive" (473-4). In this conclusion they imply that summer-time marijuana use is more apt to occur in public places and therefore be subject to greater police attention. For the routine activities thesis to explain the observed seasonal pattern it would be necessary to show seasonal pattern of offending among marijuana users, seasonal variation in styles of marijuana use (visibility), or seasonal variation in styles of policing.

The final explanation suggested here is to account for the differences between observed patterns for marijuana and cocaine use. It is suggested that different drugs produce different "elasticities of addiction." This thesis suggests that demand for marijuana is more elastic than cocaine and that makes possible seasonal variability for marijuana use and predicts greater seasonal constancy for cocaine use. For this thesis to be supported it would be necessary to demonstrate that aggregate demand for marijuana among arrestees was more elastic (take it or leave it) and that the aggregate demand for cocaine among arrestees is relatively inelastic (got to have it).

On balance it seems that seasonal patterns of drug use are more likely to "…have societal rather than a biological explanation" (Kovalenko, et al., 2000:116). The question that remains is which of the many plausible social explanations will prove most useful.

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