IDRS

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Key findings

- Given the importance of reporting systems such as the IDRS in detecting trends over time it is vital that valid trend inferences are drawn from the data.
- The impact of excluding previously participating respondents in statistical analyses of trends in drug use over time is minimal when analysing the full national data. However, it is substantial when analysing trends in drug use at the jurisdictional level.
- A method is available (and syntax is provided) to correct for the correlated nature of the data which provides a more conservative and accurate estimate of the variance around estimated trend coefficients.

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Estimating trends in the prevalence of drug use over time amongst regular injecting drug users

The Illicit Drug Reporting System (IDRS) is a data collection methodology that follows a serial cross-sectional design (Hando et al., 1998). In this design samples of injecting drug users are recruited and interviewed on a yearly basis in order to collect drug use information. This information can be used to detect trends over time in the use of drugs. It is clear, both from anecdotal evidence and from actual self-report, that a certain percentage of the respondents to the IDRS survey in any given year have also participated in the survey in previous years. However, in order to maintain the anonymity necessary for the valid reporting of sensitive information such as illicit drug use unique subject identification numbers are not assigned to each individual. Data from the IDRS have, in the past, been used for descriptive purposes only, to characterise but not to draw statistical inferences regarding the trend in drug use and related factors over time (e.g. Degenhardt et al., 2008; Day et al., 2006; Roxburgh et al., 2004; Darke et al., 2002). When these data are statistically analysed it is typical to exclude from all analyses those subjects who report participating in previous years. Standard regression analyses of changes over time that treat all observations as independent from one another can then be carried out. However, this practice of excluding subjects has the potential to bias estimates of the trends in drug use over time as those excluded participants are likely to be different, in important ways, to those who report first time participation. There has been no systematic examination of the potential bias in trend estimation introduced by excluding from trend analyses those sub-samples who report prior participation in the survey.

An additional complication arises when analysing data obtained in the IDRS. As mentioned above, unique subject identification information is not collected. In the absence of unique subject identification information it is not possible to link a subject's data from one year with the *same* subject's data in previous years. Standard ordinary least squares regression

analyses of changes over time treat the samples as completely independent of one another. What are the implications of erroneously treating the samples as completely independent of one another? Responses from the same respondent will likely be positively correlated over time. It has been shown that positive correlation over time does not bias estimated parameters obtained from statistical analysis. For example, an estimated slope parameter in a regression analysis of changes in the prevalence of heroin use over time will remain unbiased in the presence of positive correlation. However, positive correlation can result in an underestimation of the variance around these estimated parameters. If the variance around an estimated slope parameter is underestimated this can lead to false rejection of the null hypothesis of no change (in other words an inflated Type I error rate). In practical terms this means there is the potential to falsely conclude that the prevalence of heroin use is increasing (or decreasing) over time when in fact no temporal changes have occurred. Given the importance of reporting systems such as the IDRS in detecting trends over time it is vital that valid trend inferences are drawn from the data.

If each person who participated in the IDRS surveys were assigned a unique subject identifier and that subject identifier was provided by the respondent every year in which they completed the survey then it would be possible to link respondents over time and to use the method of generalized estimating equations with the robust variance estimator (Liang & Zeger, 1986) to obtain unbiased population-averaged estimates of regression parameters and their variance. However, as mentioned above, this information is not available and in its absence we need a method of obtaining a conservative estimate of variance (that is, a method that corrects the variance for the potentially correlated responses), to ensure that the Type I error rate is no larger than that specified for the analysis.

Mountford et al. (2007) have recently proposed a method for examining trends in prevalence over time when there is no unique subject identifier. They argue that a conservative estimate of the variance around estimated regression parameters (both intercept and slope parameters) can be obtained by maximizing the correlation between variables of interest over time. The practical basis of the method involves linking subjects' responses together according to certain rules, assigning pseudo-subject identifiers and analyzing the data as if they contained repeated observations over time using the traditional method of GEE with the robust variance estimator.

The aims of the current study are to use eight years worth of data from the IDRS:

1. To examine the bias (if any) in estimated linear trends in drug use over time introduced by removing from the data set those subjects who report that they participated in the survey in previous years.
2. To compare the estimated variance of the estimated linear trend in drug use over time when the samples are treated as completely independent of one another compared to when the analysis is corrected from the potential positive correlation between measurements using the methods proposed by Mountford et al. (2007).

All of these analyses will be carried out for 14 different drugs. Analyses will be carried out in the total national sample as well as separately for each state/territory in Australia. The reason for repeating the analysis in each state/territory is to explore the impact on the inferences drawn of smaller, yet meaningfully defined, sample sizes.

Method

Sample

The total sample consisted of all subjects interviewed as part of the Australian Illicit Drug Reporting System between the years of 2001 and 2008. The characteristics of subjects interviewed in each year are presented in Table 1. The 14 drugs studied were heroin, methadone, morphine, speed powder, amphetamine liquid, base/point/wax, ice/shabu/crystal, amphetamine-type stimulants (a combination of the previous four types of amphetamine), cocaine, hallucinogens, ecstasy, benzodiazepines, alcohol and cannabis.

Statistical analysis

To address the first aim generalized estimating equations (GEE) were used to estimate linear trends over time in the prevalence of recent (past 6 months) drug use for 14 different drugs both nationally and by state/territory of Australia. All analyses were carried out under two separate conditions. The first condition involved an analysis of all available data, that is, all subjects interviewed in a given year were included in the analysis regardless of whether or not they had participated in the survey in previous years. The second condition involved an analysis of data excluding subjects who reported that they had participated in the survey at any time in the past. Under both conditions all observations were assumed to be independent from each other. This assumption is only realistic for the sub-sample of first-time responders. However, for the purposes of

examining the potential bias in trend estimation introduced by excluding subjects from analyses all factors, apart from the composition of the samples, were made identical.

The estimated regression slopes along with their associated standard errors, Wald chi-squared statistic and probability values are reported for analyses of the national data. Additionally, the ratio of the estimated regression slopes under the two conditions was calculated as a measure of how much bigger (or smaller) one regression slope is compared to the other. Ratios greater than three or less than 0.33 were considered indicative of a substantial impact from excluding subjects from the analysis. A negative ratio indicates that the estimated regression slope has a different sign when calculated under the two conditions (e.g. the trend may be shown to increase when estimated in the full sample, yet may be shown to decrease when estimated in the sub-sample of first-time responders). All GEE models used an identity link function and modeled the outcome as a Bernoulli variable.

In the first set of analyses just described all subjects (under both conditions) are treated as independent from all others and no linking of subjects is carried out. In this regard the estimated slope parameters derived from the GEE analyses are exactly the same as those derived from a standard regression analysis with the probability of drug use (for each drug separately) as the outcome variable and a "year of interview" variable (coded from 1 to 8 representing 2001 to 2008) as the predictor variable. From these models the coefficient associated with the "year of interview" variable is interpreted as the constant linear change in the probability of drug use associated with a one year increase in time.

To address the second aim the methods of Mountford et al. (2007) were applied in order to achieve conservative and thus potentially more appropriate estimates of the variance around the intercept and slope parameters. These methods involve re-organising and linking the data across years according to a set of rules. The rules under which subjects' responses are linked differ depending on whether one is attempting to obtain a conservative estimate of the variance of an estimated intercept or a conservative estimate of the variance of an estimated slope in a regression analysis. It can be shown that a conservative estimate of the variance of an estimated intercept can be obtained by configuring the data so as to achieve the maximum possible correlation between pairs of measurements over time. To achieve this maximum correlation we attempt to match as many subjects with a "success" (i.e. endorsing use of a given drug) at a given time point to a "success" at all other time points. At the same time we try to match as many subjects with a "failure" (i.e. not endorsing use of a given drug) at a given time point to a "failure" at all other time points. This is achieved by creating a variable representing use of a given drug where a code of 1 is given to those who endorse use and 0 for those who do not endorse use, then sorting this variable in descending order at each time point, merging the time points together and assigning a pseudoidentifier to each row of the merged data set. Using the data in this form we can obtain the GEE estimate of the intercept under the assumption of independence but we use the robust variance estimator to obtain a conservative estimate of the variance around the estimated intercept.

The methods are similar but slightly more complicated to obtain a conservative estimate of the variance of an estimated slope in a regression analysis. In this situation it can be shown that a conservative estimate of the variance of an estimated slope can be obtained by configuring the data so as to achieve the maximum possible correlation between pairs of measurements over all time points equal or prior to the average time point and 0 correlation between pairs of measurements over all remaining time points. As described above we achieve maximal correlation by matching as many subjects as possible with successes and as many subjects as possible with failures. To achieve 0 correlation (or as close as possible to 0 correlation) we randomly match pairs of observations. Once both these procedures have been carried out a pseudoidentifier is assigned to each row of the merged data set. Figures 1 and 2 show an example of data sets that have been re-organised and linked so as to achieve conservative estimates of variance around the estimated intercept (Figure 1) and slope (Figure 2) parameters.

Note that the methods described above sort the subjects in different ways at different time points. However, the number of successes (i.e. the number who report use of a given drug) at each time point does not change. Therefore, the estimates of the regression parameters remain the same even when the data are re-sorted in different ways. Both the data manipulation steps and the GEE modeling (using the xtgee procedure) were carried out in Stata Version 9.2 (Stata Corporation, 2009). Example syntax to carry out these data manipulations and analyses will be available on the Drug Trends page of the NDARC website.

Results

The demographic characteristics of each of the eight samples are presented in Table 1. As can be seen, the samples are composed mostly of English-speaking, not employed males. An additional characteristic, whether or not the respondent self-reported previous participation in the IDRS survey, is also shown in Table 1. These data show that, depending on the year, as high as one in three respondents to the IDRS survey reported that they had participated in the same survey at least once previously. It is interesting to note that the average age of respondents has increased over time by close to one year of age per calendar year.

The results in Table 2 and 3 address the first aim of the current study. Table 2 shows the estimated linear trends in drug use over time for each drug firstly among the total national sample and then excluding those who report previous participation in the IDRS survey. The regression coefficient (multiplied by 100) can be interpreted as the constant linear percentage change in the prevalence of drug use over time. For example, the coefficient associated with heroin use in the total sample is -0.0145907 and is interpreted as demonstrating that the prevalence of heroin use is decreasing at an estimated 1.5% per year over the years 2001 to 2008. The results in Table 1 demonstrate that the conclusions drawn regarding trends in the prevalence of drug use over time would not differ had we chosen to restrict analyses to the sub-sample who reported no previous participation in the IDRS survey. The ratios presented in the last column provide a measure of how different the two estimated regression parameters for each drug are relative to each other. The value of -0.26 for methadone suggests that the estimated regression parameter for the total sample is one quarter the size of that for the sample excluding previous respondents. The negative size also points to the fact that the two linear trends go in opposite directions.

Table 3 presents information for the linear trends in drug use separated out for each state/territory of Australia. Instead of presenting all statistical information contained in Table 2, Table 3 just contains the p-value associated with the trend coefficient as well as the ratio of trend coefficients. Pairs of p-values that straddle either side of the nominal p-value of 0.05 are italicised to indicate those trends that might result in different substantive conclusions depending on the sample chosen for analysis. Of the 110 possible pairs of p-values associated with linear trends in drug use[1], 12 (11%) showed indication of different substantive conclusions depending on the sample chosen for analysis. It is worth noting that more than half of these 12 pairs were found in analysis of the NT samples. In eight out of these 12 pairs a statistically significant (with alpha set at 0.05) linear trend was observed in the sub-sample who self-reported no previous participation in the IDRS surveys but not in the total sample. In the other 4 pairs the statistically significant difference was found in the total sample but not in the sub-sample. Ratios of trend coefficients that are negative in sign and/or greater than three or less than 0.33 are also bolded to indicate situations in which to choice of analysis sample had a substantial relative impact on trend estimation. Nine of the 110 ratios were negative in sign demonstrating that the trend was in a different direction depending on which sample was chosen for analysis. However, in no case did these opposite trends reach statistical significance. A further 12 ratios exceeded the arbitrary cut-off of greater than three or less than 0.33.

The results in Table 4 and 5 address the second aim of the current study. Table 4 shows the estimated linear trends in drug use over time for each drug firstly treating the total sample as if it were made up of completely independent observations (i.e. no overlap in subjects across the eight yearly samples) and secondly by correcting for the potential correlation between observations using the methods outlined in Mountford et al. (2007). As described in the methods the application of the Mountford et al. (2007) method yields more conservative estimates of the variance of estimated trend coefficients. Therefore, the critical variables to examine are those that demonstrate the presence of a statistically significant trend when the samples are treated as completely independent and the absence of a statistically significant trend when the samples are maximally correlated. As can be seen in Table 4 this does not occur for any of the analysed drug use variables. The ratio of standard errors presented in the last column of Tables 4 can be interpreted as "design effects" or the amount by which the variance is underestimated should the samples be treated as completely independent of one another. Across the 14 drugs the ratios are largely consistent with one another having a mean of 1.67.

When the samples are split by the states/territories of Australia the impact of ignoring the correlated nature of the data is more substantial. Of the 111 possible pairs of p-values[2] 26 (23%) demonstrated different substantive conclusions

1 14 drugs by 8 states/territories (14*8=112) with two GEE analyses failing to converge, one examining the trend in heroin use in Tasmania and one examining the trend in amphetamine liquid use in Tasmania.

2 The GEE analysis of the linear trend in amphetamine liquid use in Tasmania did not converge.

Table 1. Demographic characteristics of respondents and percent of respondents reporting prior involvement in IDRS by year of interview, 2001-2008.

	2001 (n=951)	2002 (n=929)	2003 (n=970)	2004 (n=948)	2005 (n=943)	2006 (n=914)	2007 (n=909)	2008 (n=909)
Sex								
Male (%)	66.9	64.0	64.0	65.8	64.3	64.4	66.4	66.5
Female (%)	33.1	36.0	36.0	34.2	35.7	35.6	33.6	33.4
Age (Mean, SD)	30.1 (8.4)	31.1 (8.2)	32.9 (8.6)	33.1 (8.6)	34.1 (8.8)	34.5 (9.0)	35.8 (8.9)	36.7 (8.8)
Education								
School only (%)	54.6	53.3	50.8	53.0	53.3	51.2	52.7	47.2
Trade/technical (%)	36.8	36.9	38.8	37.0	35.7	39.4	36.5	40.4
University/college (%)	8.6	9.8	10.4	10.0	11.0	9.4	10.7	12.4
Employment[1]								
Not employed (%)	72.9	72.9	75.7	76.7	72.9	77.4	79.0	76.9
Employed (%)	15.8	15.6	16.6	15.8	17.7	16.0	14.4	16.3
Student (%)	4.2	3.3	2.4	1.6	2.8	1.6	0.8	0.9
Home duties (%)	3.7	4.3	5.3	5.9	6.7	5.0	3.1	3.2
Language spoken at home								
English (%)	95.5	95.7	96.9	95.4	97.1	96.5	94.9	94.0
Other (%)	4.5	4.3	3.1	4.6	2.9	3.5	5.1	6.0
ATSI								
Yes (%)	13.9	14.4	14.4	10.1	12.0	13.2	14.9	11.0
No (%)	86.1	85.6	85.6	89.9	88.0	86.8	85.1	89.0
State								
NSW	17.1	17.0	15.9	16.6	16.3	16.6	16.8	16.6
ACT	10.5	10.8	10.3	10.5	13.3	10.9	11.1	11.1
VIC	15.9	16.8	15.7	15.8	15.9	16.4	16.5	16.5
TAS	10.5	10.8	10.3	10.5	10.6	10.9	11.0	11.0
SA	10.5	10.8	12.4	10.7	10.7	10.9	11.0	11.0
WA	10.5	10.8	10.3	10.5	10.6	10.9	8.8	11.0
NT	14.2	11.9	11.2	11.7	11.3	10.9	11.7	11.3
QLD	10.7	11.2	13.9	13.6	11.2	12.3	13.1	11.4
Participated in IDRS in previous years								
Yes (%)	-[2]	21.8	28.8	31.0	33.7	31.3	30.5	31.4
No (%)	-[2]	74.2	67.2	66.3	63.1	66.2	64.8	64.1
Don't know (%)	-[2]	4.0	4.0	2.7	3.2	2.5	4.8	4.5

1. Percentages do not sum to 100% for years 2001 and 2002 due to the inclusion of an additional response category "sex worker" which was assessed as a separate question from 2003 onwards. Percentages do not sum to 100% for years 2007 and 2008 due to inclusion of additional response categories for "work and study" and "other" which are not included in previous years.
2. Data are not available for 2001.

Table 2. Estimated linear trends in drug use over time, 2001-2008, in the total national sample (N=7473) and excluding subjects who reported previous participation in the IDRS (N=5542).

Drug category	Sample composition	Regression coefficient	Standard error	p-value	Ratio of regression coefficients
Heroin	All data	-.0145907	.0024356	0.000	1.98
	Subsample	-.0073767	.0027000	0.006	
Methadone	All data	.0008274	.0025257	0.743	**-0.26**
	Subsample	-.0031256	.0028265	0.269	
Morphine	All data	.0096012	.002526	0.000	1.29
	Subsample	.0074474	.0028398	0.009	
Speed powder	All data	-.0104315	.002512	0.000	1.18
	Subsample	-.0088479	.0028234	0.002	
Amphetamine	All data	-.0110331	.0012769	0.000	0.99
liquid	Subsample	-.0111041	.0015338	0.000	
Base/wax/point	All data	-.0182155	.0023471	0.000	1.21
	Subsample	-.0150779	.0026792	0.000	
Ice/shabu/crystal	All data	.0038672	.0025316	0.127	1.00
	Subsample	.0038563	.0028526	0.176	
Amphetamine-	All data	-.0039902	.0022344	0.074	2.59
type stimulants	Subsample	-.0015383	.0024787	0.535	
Cocaine	All data	-.0129605	.002182	0.000	1.14
	Subsample	-.0113398	.00254	0.000	
Hallucinogens	All data	-.0105947	.0015139	0.000	0.89
	Subsample	-.0119226	.0017457	0.000	
Ecstasy	All data	-.0143931	.0022357	0.000	1.05
	Subsample	-.0136859	.0025513	0.000	
Benzodiazepines	All data	.0028057	.0024202	0.246	0.83
	Subsample	.0033809	.0027366	0.217	
Alcohol	All data	-.0116811	.0023883	0.000	0.99
	Subsample	-.0118299	.002685	0.000	
Cannabis	All data	-.0090037	.0019214	0.000	0.85
	Subsample	-.0106081	.0021703	0.000	

Table 3. Estimated statistical significance of linear trends in drug use over time, 2001-2008, split by state/territory of Australia

Drug	NSW		ACT		VIC		TAS		SA		WA		NT		QLD	
	p	ratio	p	ratio	p	ratio	p	ratio	p	ratio	p	ratio	p	ratio	p	ratio
Heroin	0.000	1.09	0.010	0.76	0.000	0.97	-	-	0.816	**-0.34**	0.816	0.37	0.000	1.41	0.825	**0.31**
	0.000		0.006		0.000		-		0.541		0.584		0.004		0.496	
Methadone	0.088	1.35	0.845	**0.18**	0.006	0.98	0.007	0.55	0.376	0.45	0.203	**-8.34**	0.281	1.05	0.015	0.84
	0.241		0.372		0.008		0.000		0.067		0.886		0.433		0.005	
Morphine	0.000	0.96	0.067	0.92	0.802	**-0.37**	0.848	**0.12**	0.476	**4.32**	0.436	0.50	0.676	0.53	0.000	0.99
	0.000		0.095		0.518		0.216		0.881		0.171		0.555		0.000	
Speed	0.935	**-0.13**	*0.077*	0.74	0.101	1.16	0.000	0.85	0.001	1.32	0.000	1.57	*0.029*	**32.41**	0.001	1.19
	0.562		*0.044*		0.183		0.000		0.025		0.002		*0.959*		0.007	
Amphet.	0.369	0.50	0.002	0.87	*0.036*	0.99	-	-	0.000	0.93	0.000	0.91	*0.000*	1.78	0.000	1.05
	0.083		0.005		*0.055*		-		0.001		0.000		*0.097*		0.001	
Base	0.000	1.02	0.313	0.77	0.000	1.02	0.000	1.60	0.000	1.23	0.000	1.12	0.067	**4.13**	0.001	1.10
	0.000		0.274		0.000		0.041		0.004		0.000		0.748		0.003	
Ice	0.000	1.06	0.000	1.39	0.838	**-1.19**	*0.058*	0.69	*0.035*	1.05	0.000	1.27	*0.297*	0.36	0.000	0.99
	0.000		0.011		0.872		*0.032*		*0.068*		0.001		*0.035*		0.001	
ATS	0.000	1.14	0.195	**4.75**	0.150	1.22	0.384	1.45	*0.040*	2.98	0.000	2.15	*0.047*	9.15	0.000	1.16
	0.000		0.814		0.266		0.645		*0.512*		0.042		*0.868*		0.000	
Cocaine	0.000	0.93	0.015	0.63	0.725	1.10	0.097	1.04	0.000	1.01	0.038	0.92	*0.026*	1.33	0.020	1.08
	0.000		0.001		0.766		0.254		0.000		0.048		*0.267*		0.046	
Hallucinogens	0.086	0.79	0.600	0.79	0.008	1.08	0.146	0.79	0.000	1.05	0.003	1.07	0.000	0.92	0.001	0.97
	0.053		0.600		0.025		0.165		0.003		0.018		0.001		0.001	
Ecstasy	0.000	1.13	0.025	0.92	0.006	0.97	0.001	1.00	0.085	1.12	0.000	1.17	*0.001*	**5.93**	0.004	1.29
	0.004		0.042		0.008		0.009		0.171		0.001		*0.683*		0.033	
Benzo.	0.003	1.16	0.600	0.60	0.009	1.15	0.898	**-0.26**	0.322	0.74	0.678	**-7.01**	0.886	**0.14**	0.895	**-4.51**
	0.018		0.461		0.033		0.713		0.225		0.959		0.426		0.978	
Alcohol	0.369	1.11	0.840	**-0.60**	0.032	0.93	0.820	**0.15**	0.113	1.02	0.000	1.07	*0.019*	1.20	0.005	1.26
	0.450		0.773		0.030		0.265		0.156		0.000		*0.128*		0.031	
Cannabis	0.587	0.57	0.366	0.49	0.002	1.21	0.033	0.65	*0.046*	1.01	0.000	1.00	0.823	**0.14**	0.504	0.80
	0.374		0.127		0.014		0.014		*0.075*		0.000		0.248		0.426	

Table 4. Estimated linear trends in drug use over time, 2001-2008, under the assumption of independent observations and adjusting for the correlated nature of the observations.

Drug category	Sample composition	Regression coefficient	Standard error	p-value	Ratio of standard errors
Heroin	Independent	-.0145907	.0024356	0.000	1.71
	Correlated	-.0145907	.004173	0.000	
Methadone	Independent	.0008274	.0025257	0.743	1.72
	Correlated	.0008274	.0043476	0.849	
Morphine	Independent	.0096012	.002526	0.000	1.70
	Correlated	.0096012	.0042945	0.025	
Speed powder	Independent	-.0104315	.002512	0.000	1.69
	Correlated	-.0104315	.0042539	0.014	
Amphetamine	Independent	-.0110331	.0012769	0.000	1.62
liquid	Correlated	-.0110331	.0020744	0.000	
Base/wax/point	Independent	-.0182155	.0023471	0.000	1.70
	Correlated	-.0182155	.0039901	0.000	
Ice/shabu/crystal	Independent	.0038672	.0025316	0.127	1.64
	Correlated	.0038672	.0041582	0.352	
Amphetamine-	Independent	-.0039902	.0022344	0.074	1.62
type stimulants	Correlated	-.0039902	.0036301	0.352	
Cocaine	Independent	-.0129605	.002182	0.000	1.65
	Correlated	-.0129605	.0036023	0.000	
Hallucinogens	Independent	-.0105947	.0015139	0.000	1.60
	Correlated	-.0105947	.0024199	0.000	
Ecstasy	Independent	-.0143931	.0022357	0.000	1.70
	Correlated	-.0143931	.0038104	0.000	
Benzodiazepines	Independent	.0028057	.0024202	0.246	1.70
	Correlated	.0028057	.004114	0.495	
Alcohol	Independent	-.0116811	.0023883	0.000	1.66
	Correlated	-.0116811	.003971	0.003	
Cannabis	Independent	-.0090037	.0019214	0.000	1.63
	Correlated	-.0090037	.0031369	0.004	

Table 5. Estimated statistical significance of linear trends in drug use over time, 2001-2008, split by state/territory of Australia.

Drug	NSW		ACT		VIC		TAS		SA		WA		NT		QLD	
	p	ratio	p	ratio	p	ratio	p	ratio	p	ratio	p	ratio	p	ratio	p	ratio
Heroin	0.000	1.56	*0.010*	1.51	0.000	1.60	0.000	1.64	0.816	1.68	0.816	1.69	0.000	1.44	0.825	1.54
	0.000		*0.091*		0.005		0.000		0.890		0.890		0.000		0.885	
Methadone	0.088	1.57	0.845	1.77	*0.006*	1.57	*0.007*	1.67	0.376	1.68	0.203	1.66	0.281	1.63	*0.015*	1.69
	0.277		0.912		*0.079*		*0.109*		0.597		0.442		0.510		*0.150*	
Morphine	0.000	1.58	0.067	1.62	0.802	1.61	0.848	1.67	0.476	1.73	0.436	1.59	0.676	1.36	0.000	1.64
	0.000		0.257		0.876		0.909		0.680		0.625		0.759		0.020	
Speed	0.935	1.63	0.077	1.66	0.101	1.63	0.000	1.61	*0.001*	1.72	0.000	1.63	*0.029*	1.55	0.001	1.50
	0.960		0.287		0.315		0.009		*0.055*		0.001		*0.158*		0.024	
Amphet.	0.369	1.58	0.002	1.35	*0.036*	1.53	-	-	0.000	1.60	0.000	1.37	0.000	1.67	0.000	1.63
	0.570		0.020		*0.170*		-		0.018		0.001		0.008		0.022	
Base	0.000	1.61	0.313	1.55	0.000	1.54	0.000	1.51	0.000	1.72	0.000	1.61	0.067	1.68	0.001	1.56
	0.006		0.515		0.000		0.005		0.023		0.000		0.276		0.030	
Ice	0.000	1.53	0.000	1.41	0.838	1.53	0.058	1.53	*0.035*	1.77	0.000	1.51	0.297	1.70	0.000	1.59
	0.000		0.004		0.894		0.214		*0.233*		0.002		0.539		0.028	
ATS	0.000	1.59	0.195	1.55	0.150	1.62	0.384	1.53	*0.040*	1.65	0.000	1.45	*0.047*	1.47	0.000	1.37
	0.000		0.404		0.375		0.568		*0.213*		0.002		*0.175*		0.001	
Cocaine	0.000	1.57	*0.015*	1.42	0.725	1.58	0.097	1.54	0.000	1.49	*0.038*	1.50	*0.026*	1.46	*0.020*	1.56
	0.001		*0.086*		0.823		0.281		0.000		*0.167*		*0.128*		*0.133*	
Hallucinogens	0.086	1.47	0.600	1.44	*0.008*	1.47	0.146	1.63	0.000	1.57	0.003	1.47	0.000	1.46	0.001	1.50
	0.241		0.715		*0.071*		0.373		0.021		0.043		0.003		0.024	
Ecstasy	0.000	1.61	*0.025*	1.63	*0.006*	1.63	0.001	1.59	0.085	1.69	0.000	1.69	0.001	1.66	*0.004*	1.61
	0.026		*0.167*		*0.092*		0.035		0.306		0.006		0.039		*0.070*	
Benzo.	*0.003*	1.60	0.600	1.74	*0.009*	1.70	0.898	1.63	0.322	1.68	0.678	1.53	0.886	1.65	0.895	1.69
	0.065		0.764		*0.127*		0.937		0.556		0.786		0.931		0.938	
Alcohol	0.369	1.54	0.840	1.63	*0.032*	1.62	0.820	1.76	0.113	1.72	0.000	1.55	*0.019*	1.50	*0.005*	1.51
	0.559		0.902		*0.186*		0.897		0.355		0.006		*0.119*		*0.060*	
Cannabis	0.587	1.68	0.366	1.50	*0.002*	1.61	*0.033*	1.78	*0.046*	1.63	0.000	1.51	0.823	1.37	0.504	1.36
	0.747		0.548		*0.055*		*0.230*		*0.219*		0.000		0.871		0.623	

depending on whether the samples were treated as independent or correlated. The ratio of the standard errors for each state/territory are again largely consistent with one another having a grand mean of 1.58 across all drugs and all state/territories (average ratios per state/territory range from 1.54 to 1.67).

Discussion

This bulletin demonstrates the importance of correctly adjusting for the non-independence of observations found in serial cross-sectional designs such as those employed in the IDRS. The above results show that when analysing the full national sample the impacts of excluding from the analysis subjects who self-report previous participation are minimal. However, when the national samples are broken down by states/territories then there are more substantial impacts on inferences drawn from the data. Around one in ten linear trend analyses will yield different substantive conclusions depending on the sample chosen for analysis.

Correcting for the correlated nature of the data using the methods outlined in Mountford et al. (2007) provides a more conservative and accurate estimate of the variance around estimated trend coefficients and when applied to the IDRS data showed little impact when the data were analysed at the national level, but substantial impact when analysed at the state/territory level. Almost one quarter of estimated linear trends failed to reach nominal levels of statistical significance once the data were corrected for correlation. These results demonstrate that the methods outlined by Mountford et al. (2007) should be used when analyzing the IDRS data at the jurisdictional level.

While example syntax is available (see the Drug Trends page of the NDARC website) and can be adapted for different analytic scenarios it is also informative to point out that the ratio of standard errors presented in Tables 4 and 5 is a direct indication of the amount of underestimation in the standard error. Termed the design effect (Everitt, 2006), this ratio demonstrates that the standard error is underestimated by about 70% if the data are not corrected for correlation over time. By multiplying the standard error of the trend coefficient in a given trend analysis by the value of the design effect we arrive at a more conservative and realistic estimate of its standard error. If the methods outlined by Mountford et al. (2007) are not used then this crude adjustment of the standard error represents the next best method.

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Figure 1. Pictorial representation of the rules under which subjects' data are re-organised and linked to achieve an unbiased estimate of the variance around the intercept parameter.

Subject number	2001	2002	2003	2004	2005	2006	2007	2008
1	1	1	0	0	0	1	0	1
2	0	0	1	1	0	0	0	0
3	0	1	1	0	1	1	0	0
4	0	0	1	0	0	1	1	0
5	1	0	0	0	0	0	0	1
6	1	1	0	0	0	0	1	0
7	0	1	0	0	0	1	0	0
8	1	0	1	1	0	1	1	0
9	0	0	0	0	1	1	1	1
10	1	1	0	1	0	1	0	1
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
n	0	1	0	1	0	0	1	0

Subject number	2001	2002	2003	2004	2005	2006	2007	2008
1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1
3	1	1	1	1	0	1	1	1
4	1	1	1	1	0	1	1	1
5	1	1	0	0	0	1	1	0
6	0	1	0	0	0	1	0	0
7	0	0	0	0	0	1	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
n	0	0	0	0	0	0	0	0

Figure 2. Pictorial representation of the rules under which subjects' data are re-organised and linked to achieve an unbiased estimate of the variance around the slope parameter.

Subject number	2001	2002	2003	2004	2005	2006	2007	2008
1	1	1	0	0	0	1	0	1
2	0	0	1	1	0	0	0	0
3	0	1	1	0	1	1	0	0
4	0	0	1	0	0	1	1	0
5	1	0	0	0	0	0	0	1
6	1	1	0	0	0	0	1	0
7	0	1	0	0	0	1	0	0
8	1	0	1	1	0	1	1	0
9	0	0	0	0	1	1	1	1
10	1	1	0	1	0	1	0	1
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
n	0	1	0	1	0	0	1	0

Subject number	2001	2002	2003	2004	2005	2006	2007	2008
1	1	1	1	1	0	1	0	0
2	1	1	1	1	0	0	1	0
3	1	1	1	1	0	1	0	1
4	1	1	1	1	0	1	0	0
5	1	1	0	0	0	0	0	1
6	0	1	0	0	0	1	1	0
7	0	0	0	0	1	0	1	0
8	0	0	0	0	0	1	0	0
9	0	0	0	0	0	1	1	0
10	0	0	0	0	1	1	0	1
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
n	0	0	0	0	0	0	1	1