Assessing the Effects of Heavy Episodic Drinking on Interpersonal Assault Using Multilevel Modelling

Carly Lightowlers, Liverpool John Moores University
Mark Elliot, University of Manchester
Mark Tranmer, University of Manchester

Abstract

This study examines the joint development of drinking patterns and violent behaviour across the late adolescent and early adult years. It employs panel data of regular drinkers aged between 16 and 29 in England and Wales. Three nested multi-level models explore the variation accounted for within and between individuals in their propensity to commit assault controlling for their drinking behaviour. Results suggest that males and younger people are more likely to commit assault offences and that around 60% of the variation in assault is between people; the remainder being within people between occasions. Heavy episodic drinking is a significant predictor of assault in all models. Collectively, the findings point to a contemporaneous association between drinking and violent outcomes.

Introduction

The destructive impact of alcohol consumption and associated violence has been the focus of both political concern and academic debate with regards to both crime and public health implications (see for example Strategy Unit, 2004; Parker, 2005; Measham, 2006; Järvinen and Room, 2007). Young people's alcohol consumption is thought to be increasingly concentrated on single drinking occasions (heavy episodic drinking) (see Sumner and Parker, 1995; Measham, 1996; Järvinen and Room, 2007 for commentaries and reviews of the literature pertaining to young people's drinking behaviour) and such drinking patterns have been associated with interpersonal assault: young people who drink are more likely to be involved in violent incidents (see McVeigh et al., 2005; WHO, 2006; for reviews on the literature in relation to violence). Furthermore, findings from the European School Survey Project on Alcohol and Other Drugs (ESPAD) suggest that young people in the UK drink more heavily than their European counterparts and experience higher levels of alcohol-related harm (Hibell et al., 2009).

The transition between childhood and young adulthood is one in which heavy drinking and (violent) offending can feature. Criminal careers often commence in teenage years, peak in early adulthood and tail off in the twenties; this is known as the 'age-crime curve'[i] (see the review on criminal careers by Siennick and Osgood, 2008). As Sumner and Parker (1995) observe, this trajectory of offending approximately maps onto that of drinking which often starts at a similar time in the life course and co-occurs in young people. Farrington (2003) studied London males aged 8-46 since 1961 and identified the prevalence of offending increased up to age 17 before then decreasing with the peak increase in prevalence lying at the age of 14 and peak age of decrease being at age 23, with a mean age of conviction of 21. More specifically, violent offending has been found to peak between the ages of 18-33 (see studies by Laub and Sampson, 2003; Farrington, 2003) and increased levels of violence for males have consistently been indentified in longitudinal studies in the 10-19 age range, whereas females tend to decline in late teens (Huizinga et al., 2003). Huang et al. (2001) also found that the positive correlation between alcohol and aggression decreased with age from mid to late adolescence. Although their results "suggested that reducing one behaviour will probably not have a long-term impact on the other" they offer the insight that "early prevention efforts aimed at shared risk factors may reduce both contemporaneously" (Huang et al., 2001:64).

It has also been noted that problematic behaviours adopted during this period can have repercussions in adulthood. For example, Osterle et al. (2004), who studied the association of trajectories of heavy episodic drinking and during adolescence with health status and practices at age 24, identified long-term negative health consequences as a result of heavy episodic drinking during adolescence and Guo et al. (2000) find that alcohol use during childhood and adolescence can lead to continued alcohol abuse and dependence in later life.

Some longitudinal studies, have found high volume drinking to be a predictor of violent behaviour in young people (see Swahn and Donavan 2004; Blitstein et al., 2005). Conversely, White et al. (1993) found that violent behaviour led to subsequent alcohol use and Huang et al. (2001) identified both processes occuring in parallel. Thus results to date are mixed as to the causal ordering of events in the alcohol-violence relationship and further research to disentangle factors that precede and those that co-occur with violent behaviour is called for by Swahn and Donavan (2004).

Some studies have also explored the extent to which gender modifies predictors of violence: Swahn and Donovan (2004) include an interaction for gender and heavy episodic drinking which was not found to be significant. However, Blitstein et al. (2005) hypothesised that the pattern between violence and substance use may be different across genders and found that gender modified the association between drinking and violence: heavy episodic drinking was not associated with violence amongst males, whereas heavy episodic drinking suppressed the rate of violence in females. Finally, Huang et al. (2001) did not find that sex moderated the reciprocal effect of aggression and alcohol use identified in their study.

Many studies have identified an association between acute intoxication or heavy episodic drinking, and an increased risk of committing interpersonal assault (see for example Matthews and Richardson, 2005; Finney, 2004; Shepherd, 1994; Room and Rossow, 2001). However, in order to assess the extent to which such drinking patterns influence violent behavioural outcomes from a developmental perspective it is necessary to assess both the distal and proximal effects of such drinking patterns and how young people's alcohol consumption patterns impact on the potential for violent behaviour across the period of young adolescence and early adulthood. Research to date has relied heavily on cross sectional analyses (for example, Matthews and Richardson, 2005; Finney, 2004; Shepherd, 1994; Room and Rossow, 2001) and there is, comparatively little research focused on the longitudinal prediction of violence from prior drinking behaviour (above and beyond the impact current drinking behaviour) and most of these are centred on US samples of young people (see, Blitstein et al., 2005; Swahn and Donovan, 2004; White et al., 1993; Huang et al., 2001). Longitudinal studies allow for the study of within-individual changes in criminal activity over time, whereas cross-sectional studies can only examine inter-individual differences (Piquero et al., 2007). The current paper aims to elaborate on our understanding of how heavy episodic drinking patterns may influence violent outcomes in the form of assaults (both with and without injury) by asking whether violent behaviour can be predicted from current and earlier alcohol consumption patterns in young people in England and Wales.

Findings from an earlier cross-sectional study (Lightowlers, 2011) suggested that there was a contemporaneous association between heavy episodic drinking and violence in the same year and provided evidence to suggest there was no further predictive ability of prior heavy episodic drinking on the likelihood of violent offending. This supported other findings

elsewhere that substance use during early adulthood is associated with time-specific variations away from individuals' long term patterns of aggressive behaviour (see for example Hussong et al., 2004). However, the extent to which this finding holds when accounting for the natural clustering in the observations in repeated measures data will be examined here. This paper builds on the limitation - outlined in Lightowlers (2011) - associated with assuming independence between observations in repeated measures data by accounting for this in the modelling procedure.

This paper presents three nested multi-level models exploring the contribution of heavy episodic drinking in predicting the likelihood of assault as well as highlighting the variation accounted for within and between individual's propensity to commit assault controlling for their drinking behaviour and subsequently presents the final model separately for males and females. The results are then discussed with reference to the prior findings of a contemporaneous association between heavy episodic drinking and violence (Lightowlers, 2011).

Data and Methods

The survey

The UK Home Office's Offending Crime and Justice Survey (OCJS) was selected for this study: a general population study of young people aged 10-29 in England and Wales which asks about their offending as well as drinking behaviour. The survey was administered using (audio-) computer assisted interviewing (CASI)[ii] to encourage honest self-reports of offending and drug use (see Phelps et al., 2007 for further details on the administration of the survey). The OCJS was designed as a four-year rotating panel survey; that is, each year, part of the previous year's sample is re-interviewed in the same manner and is augmented by a fresh sample to ensure a representative sample of young people in each sweep. For more detail on the sampling strategy and survey design please refer to Phelps et al. (2007).

The sample

A subset of the panel sample (those who responded and were regular drinkers[iii] in the final sweep and at least on one other occasion) was employed here to run repeated measures models investigating the impact of drinking behaviour on violent behaviour over the period of childhood and young adolescence. Data from the three sweeps 2004-2006 were used in the models presented here. Panel response rates for each of the three sweeps were between 82 and 85 per cent. Given the low numbers of regular drinkers under age 16, the models run here examine the impact of drinking patterns on violent behaviour will focus specifically on those aged 16 to 29[iv]. For these models a subset of those panel respondents aged 16 to 29 that had responded on at least two occasions and for whom heavy episodic drinking measures were captured – i.e. those persons who regularly drink more than once a month and gave a response to the heavy episodic drinking questions in sweeps two (2004) to four (2006) (N=2415), as the heavy episodic drinking questions were not introduced until

the second sweep of the survey. Finally, there were 77 cases which had one or more missing values on the explanatory variables used in the final model of the analysis. For comparability sake, these cases were removed from all models. A further 4 cases were omitted as they have a missing value on the dependent variable assault and only have one occasion in the dataset once specified as those over the age of 16.

Measures

In order to capture heavy episodic drinking patterns, a frequency measure of drinking more than six/eight units in one day (for females and males respectively) was employed here[v]. This variables was captured on a six point scale between 'most days' and 'less than once every couple of months', however has been collapsed into three categories here, to aid interpretation and avoid categories with low numbers: those that do not drink heavily on single occasions (episodes), those that do so at a low frequency (once to ten times a month) and those that do so more frequently (eleven times a month or more). As heavy episodic drinking frequency was asked only of those that drank at least once a month or more the findings presented here exclude abstainers and infrequent drinkers. Thus finding presented here pertain only to regular drinkers.

To capture violent behaviour this study focuses specifically on interpersonal assault which is the most common form of violence perpetrated by young people (WHO, 2006; McVeigh et al., 2005). Violent behaviour will be measured in this instance by a composite measure of whether the respondent had committed an assault in the last year; whether or not the other party incurred an injury.

Age has been re-specified in the models here so as to start from zero at age 16, to aid interpretation of the resulting coefficients: age coefficients thus pertain to one year's increase in age starting from the age of 16 and up to the age of 29.

Of the total 2338 included individuals aged 16-29 in the current study, 46.2% were male and the average age was 20 (standard deviation of 3.15). Of these individuals, at their earliest record in the survey, just under a quarter (23%) never binge drank, over two thirds (68.7%) did so at the lower frequency (once to ten times a month) and 8.3% were classified as those that binge drank at the higher frequency of eleven times a month or more. 13.6% of the sample had committed an assault offence.

Methods

In initial, exploratory analyses (see Lightowlers, 2011) logistic regression models were run to examine the impact of heavy episodic drinking in the current and previous sweeps on committing an assault in the 2006 sweep. Those models were informative but did not account for the repeated measures design. Thus the models presented here use a multi-level repeated measures framework, which accounts for the clustering of observations over time within individuals. In such a framework, it is also "straightforward to incorporate not only covariates that are constant in time, but also changing covariates" (Snijders, 1996:408),

such as heavy episodic drinking frequency and age in this instance. It also allows for a consideration of either a random intercept in which the same rate of change for each individual is assumed or a random slopes model to allow a different rate of change for each individual. The use of such models is thus appropriate for analysing "the development curves of individuals, not only on their average level but also on the speed or acceleration of development, or on other characteristics of the way in which Y changes with time" (Snijders, 1996:408) and asking questions concerned with "differences between individuals with respect to their development curves, and which covariates have effects on the level, speed and 'shape' of development" (Snijders, 1996:408).

Data preparation was performed in SPSS version 16 and the repeated measures models were fitted using MLwiN version 2.21.

Findings

A series of binomial repeated measures models were run in hierarchical stages to examine the effects of heavy episodic drinking on violent behaviour controlling for covariates age and sex identified in previous cross-sectional analyses (see Lightowlers, 2011) as well as time (sweep year), which will be fitted as a categorical covariate given the non linear change in assault over time apparent from exploratory analyses. Table 1 illustrates the resulting coefficients for each of these stages, which will be documented and narrated in turn.

Initially a binomial null mode[vi,vii] was run to predict the outcome (assault) from the constant and sweep year (see Model 1, Table 1). The variance partition coefficient[viii] was 0.61 for this model[ix], suggesting that 61% of variation in assault is between people, the remainder between occasions. 'Coefficients from this model suggest that the overall contribution of sweep year is significant and thus worth controlling for when considering multiple overlapping cohorts (that is, people are different ages in different years). It will therefore be retained in subsequent models to avoid confounding the results and so that developmental change within people can still be assessed using this data.[x]

Age and sex were added to the model as fixed effect explanatory variables, leading to a slight reduction in the variance partition coefficient; having accounted for age and gender variation, 57% of variation in assault is between people, the remainder between occasions. Both age and sex were found to be significant predictors, with males being more likely to commit assault and with age being negatively related to the risk of committing an assault.

The model was further developed to examine the impact of heavy episodic drinking frequency on assault through the addition of dummy variables in the fixed part of the model. This highlighted a significant effect of heavy episodic drinking, with the probability of assault increasing in size with increased heavy episodic drinking frequency. Again the variance partition coefficient reduced slightly; in this model 55% of variation in assault is between people, with the remainder being between occasions. Males, people at the

younger end of the age range and those that frequently drink heavily on single episodes, especially the most frequent heavy episodic drinkers are more likely to commit assault.

The final model included an age and heavy episodic drinking interaction term to examine whether the impact of heavy episodic drinking was moderated by age. The variance partition coefficient in this model was similar to that of Model 3 (0.56) and, the interaction effects were found to be non-significant, thus suggesting it is age does not moderate the effect of heavy episodic drinking. That is, that age has a significant impact on violent outcomes as does heavy episodic drinking; however, there is no evidence of a multiplicative effect of these two variables.

To more accurately interpret the impact of age on the rate of change in violent behaviour an age squared term was entered into Model 3. The variance partition coefficient in this model (Model 5, Table 1) was 0.56 and the age squared term was significant and in a positive direction, thus modifying the negative age term slightly; age, sex and heavy episodic drinking all remained significant covariates in the model.[xi]

The models reported above include sex as a fixed effect. However, it reasonable to consider the possibility that the relationships between the explanatory and response variables may be different for males and females. We therefore also ran the models separately for men and women.

When run on male respondents only, the resulting models suggest that heavy episodic drinking remains a significant predictor of assault, increasing monotonically with the heavy the frequency of episodic drinking (see Model 3 and 4, Table 2). Age also remains significant in a negative direction with a significant positive age squared coefficient (Model 4). The variance partition coefficient reduced from 0.61 in Model 1, to 0.59 in Model 2 and then to 0.57 for model 3, which is similar to that of Model 4 (0.56) and to those in the comparable models for both genders. The reduction in the goodness of fit (DIC) of this model compared to the subsequent female only models, suggest that the impact of heavy episodic drinking is slightly more important for males than females. When comparing the variance partition coefficients here with those obtained in the female-only models (see below) they are slightly higher for males, possibly suggesting there is more variation in assault outcomes between males than females.

On examining only female respondents, findings suggest that heavy episodic drinking is once more a significant predictor of assault outcomes, however compared to the male only model the effects of low level heavy episodic drinking frequency are less pronounced. Nonetheless, as with males, the risk of an assault outcome increases with increased heavy episodic drinking frequency and age is a significant predictor also, with older respondents being less likely to commit an assault offence. Once again a small positive effect of the age squared term was present (Model 4). As with the male only model, the variance partition coefficient reduces over the first three models presented in Table 3.

Discussion

The headline result reported above confirms those using logistic regression models (Lightowlers, 2011): the risk of committing an assault offence increases monotonically with increased heavy episodic drinking frequency. However, having accounted for the inherent clustering of observations within individuals in the data,) age and gender are identified as significant predictors of assault, suggesting that males and younger people are more likely to commit assault offences (unlike the earlier logistic regression models). The positive age squared term modifies the negative effect of age in both the combined and gender specific models so that the impact of age decreases the older the young person gets. This resonates with established findings concerning violent offending trajectories and criminal careers, as we would expect offending (as well as drinking) to be highest in the early stages of this age range and to tail off towards the end. The variance partition coefficients (VPCs) suggest that around 60% of the variation in assault is between people and the remainder (around 40%) is between occasions, suggesting that considering variation in violent offending in a developmental framework is an important part of understanding this problem.

The addition of drinking to the simpler multi-level model (only controlling for sweep year, age and gender) did not reduce the variance partition coefficient dramatically and the insignificant interaction between age and heavy episodic drinking suggests that it is not necessarily the age at which young people binge drinking that is influencing violent outcomes. Taken together, these findings point to a contemporaneous association between drinking and violent outcomes – that is, it may be that increases/decreases in the probability of committing assault over time are dependent on levels of drinking. This is consistent with results reported elsewhere (see Hussong et al., 2004). There may also be other time-varying factors influencing this variation not accounted for in the current models: many other social factors are known to influence changes in offending over the life course such as: establishing an identity, starting to make decisions for oneself, selecting peers and friendship networks, deciding on educational and/or employment pathways as well as dealing with events that life throws up, thus further investigation of those pertinent to adolescence and early adulthood (such as, changing peer and friendship networks; educational and employment transitions; as well life events and changes in marital status) in this framework is warranted.

Results here suggest that there is more variation in assault outcomes between males than between females and that the effect of low frequency heavy episodic drinking appears to be slightly greater for males than females.

The models here do not examine the relationship between transitions in levels of drinking and contemporaneous transitions in violent behaviour and further analyses and research would do well to investigate this further.

Whilst some previous studies have found negative effects of early drinking or later health and social outcomes, others may hypothesise that individuals mature out of adolescent

drinking or antisocial behaviour, as highlighted by McCambridge and Rowe (2011). Each process has a potentially different implication for policy development concerned with reducing alcohol related harm and violence. "If adolescent drinking does not cause later difficulties in adulthood then intervention approaches aimed at addressing the acute consequences of alcohol, such as unintentional injuries and anti-social behaviour, may be the most appropriate solution. If causal relationships do exist, however, this approach will not address the cumulative harms produced by alcohol, unless such intervention successfully modifies the long-term relationship with alcohol, which seems unlikely" (McCambridge and Rowe, 2011:1). Evidence here does not definitively point to one or the other, however, suggests there is merit in considering contemporaneous violent behaviour and alcohol consumption alongside developmental variation in alcohol consumption over the period of young adulthood. Findings here allude to the fact that reducing alcohol consumption in late adolescence will, in turn, reduce the prevalence of violent assault offences in and immediately after drinking occasions. However, add to this that there may also be developmental fluctuations in both alcohol and violent behaviour during young adulthood.

Further evidence and more specific studies on mediators and moderators of the effects of alcohol on violent behaviour are however required to ascertain whether alcohol consumption predicts later violent behaviour. Alternative approaches such as fixed effects longitudinal models, which could examine whether a changes in alcohol consumption predict a change in the likelihood of committing assault should also be explored however these would ideally be based longer scale longitudinal data than were available here. In their review of adult consequences of adolescent alcohol consumption, McCambridge and Rowe (2011) highlight a need to develop a longer term perspective on harm reduction in relation to alcohol consumption and poor health outcomes and later alcohol problems more generally and this too would be supported by better longitudinal data relating to alcohol consumption and related harms.

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Table 1 Model coefficients: predicting assault (base no assault offence)

	Model 1	P value	Model 2	P value	Model 3	P value	Model 4	P value	Model 5	P value
Constant	-3.023	**	0.401	n.s	-0.288	n.s	-2.247	**	8.103	**
Sweep 2005	-0.136	n.s	-0.119	n.s	-0.113	n.s	-0.1	n.s	-0.136	n.s
Sweep 2006	-0.864	**	-0.832	**	-0.789	**	-0.795	**	-0.912	**
Age-16			-0.189	**	-0.189	**	-0.094	*	-1.004	**
Male			1.024	**	0.924	**	0.951	**	0.946	**
Heavy episodic drinking low (reference category 'never')					0.953	**	3.221	**	0.989	**
Heavy episodic drinking high (reference category 'never')					1.561	**	4.479	*	1.627	**
Heavy episodic drinking low.Age-16							-0.114	*		
Heavy episodic high.Age-16							-0.146	n.s		
Age squared									0.019	**
Constant/Constant	5.337		4.559		3.95		4.225		4.175	
DIC:	2514.633		2487.159		2496.157		2482.807		2480.195	
Units: caseref	2338		2338		2338		2338		2338	
Units: sweep	4108		4108		4108		4108		4108	

*p ≤ .05; **p ≤ .01, n.s. = non significant

Model 1: overall contribution of sweep **, variance partition coefficient = 0.62; Model 2: overall contribution of sweep **, variance partition coefficient = 0.58; Model 3: overall contribution of sweep **, overall contribution of heavy episodic drinking **, variance partition coefficient = 0.55; Model 4: overall contribution of sweep **, overall contribution of heavy episodic drinking **, overall contribution of interaction *, variance partition coefficient = 0.56; Model 5: overall contribution of sweep **, overall contribution of heavy episodic drinking **, variance partition coefficient = 0.56.

Table 2 Model coefficients: predicting assault (base no assault offence) males

	Model 1	P value	Model 2	P value	Model 3	P value	Model 4	P value
Response	assault		assault		assault		assault	
Constant	-2.415	**	1.525	*	0.926	n.s	3.191	n.s
Sweep 2005	-0.291	n.s	-0.254	n.s	-0.212	n.s	-0.228	n.s
Sweep 2006	-0.953	**	-0.897	**	-0.84	**	-0.881	**
Age-16			-0.194	**	-0.209	**	-0.424	n.s
Heavy episodic drinking low (reference category 'never')					0.989	**	0.999	**
Heavy episodic drinking high (reference category 'never')					1.584	**	1.607	**
Age squared							0.005	n.s
Constant/Constant	5.391		5.006		4.63		4.69	
Level: sweep								
DIC:	1428.444		1416.874		1417.398		1419.09	
Units: caseref	1079		1079		1079		1079	
Units: sweep	1926		1926		1926		1926	

*p ≤ .05; **p ≤ .01, n.s. = non significant

Model 1: overall contribution of sweep **, variance partition coefficient= 0.62; Model 2: overall contribution of sweep **, variance partition coefficient= 0.60
Model 3: overall contribution of sweep **, overall contribution of heavy episodic drinking **, variance partition coefficient = 0.58
Model 4: overall contribution of sweep **, overall contribution of heavy episodic drinking **, VPC = 0.59

Table 3 Model coefficients: predicting assault (base no assault offence) females

	Model 1	P value	Model 2	P value	Model 3	P value	Model 4	P value
Response	assault		assault		assault		assault	
Constant	-3.486	**	0.646	n.s	-0.144	n.s	16.87	**
Sweep 2005	0.055	n.s	0.027	n.s	0.006	n.s	-0.055	n.s
Sweep 2006	-0.74	**	-0.78	**	-0.78	**	-1.069	**
Age-16			-0.198	**	-0.193	**	-1.849	**
Heavy episodic drinking low (reference category 'never')					0.874	**	0.947	**
Heavy episodic drinking high (reference category 'never')					1.541	**	1.643	**
Age squared							0.039	**
Constant/Constant	4.414		4.018		3.789		3.862	
Level: sweep								
DIC:	1091.993		1079.954		1084.544		1064.951	
Units: caseref	1259		1259		1259		1259	
Units: sweep	2182		2182		2182		2182	

*p ≤ .05; **p ≤ .01, n.s. = non significant

Model 1: overall contribution of sweep **, variance partition coefficient = 0.57 Model 2: overall contribution of sweep **, variance partition coefficient= 0.55
Model 3: overall contribution of sweep **, overall contribution of heavy episodic drinking **, variance partition coefficient= 0.54
Model 4: overall contribution of sweep **, overall contribution of heavy episodic drinking **, VPC = 0.54

[i] The term 'age-crime curve' refers to the curvilinear relationship frequently observed between age and offending. It describes the tendency for offending to peak in adolescence and subsequently decline with age.
[ii] Audio-CASI allows respondents to listen to questions and possible answers via headphones before entering their response directly into a computer.
[iii] These are people who reported drinking at least once a month. It was decided to exclude from the subset those who reported drinking less frequently than this (including abstainers) as we wished to make the specific comparison comparing regular drinkers to heavy episodic drinkers, with a control group of regular drinkers who did not binge drink. The inclusion of the effective non-drinkers would have created a heterogeneous control group.
[iv] The number of under 16 year old regular drinkers was 430 (29.2% of all those under the age of 16 in the sample) compared to 2394 regular drinkers over 16 (77.8% of all those aged 16 or over in the sample). As we wished to include age as a covariate the small numbers made the models unstable. Furthermore, the small proportion of under 16 drinkers gives reason to be concerned that that group maybe categorically different from those in the over 16 year old group.
[v] A unit is a measurement of alcohol used in the UK to define recommended limits for alcohol consumption. One unit equates to 10 millilitres or 8 grams of pure ethanol; approximately the equivalent amount of alcohol contained in half a pint of beer or lager, a small glass of wine, or in a standard measure of spirits (Department of Health, 1995).
[vi] Even in the "null" model sweep year was included as a control as we wished to factor out any period effect, to allow for possible fluctuations in violent offending over the three years.
[vii] For the multilevel logistic regression models, Monte Carlo Markov Chain (MCMC) estimation was used, implemented via MLwiN (Browne, 2009). MCMC estimation generally leads to better estimates of the model parameters than other methods, such as Penalised Quasi Likelihood (PQL). All models presented in the current paper employ MCMC with 20000 iterations.
[viii] In interval response models this is treated as equivalent to the interclass correlation (sometimes referred to as *Rho*). However in binary response models there is no such equivalence.
[ix] This was calculated using the latent variable approach (see Snijders and Bosker (1999) for a description and Browne et al (2005) for an analytical critique of this and other approaches).
[x] It may at first sight seem confusing that we have a random effect of occasion and a fixed effect of sweep year since they appear conflated. However, sweep year gives a period effect which effectively control for the mean level of assault in any one year, still allowing for variation within individuals across time. We avoid the identification problem because we do not control for cohort.
[xi] Model 5 has the lowest DIC indicating that it was best able to explain the response variable. We cannot formally test for differences between the models using the likelihood ratios as we have used MCMC rather than maximum likelihood to estimate our models.