Long-term follow-up of criminal activity with adjudicated youth in Ontario: Identifying offence trajectories and predictors/correlates of trajectory group membership[1]

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ABSTRACT

This article examines the criminal trajectories and childhood predictors and adolescent correlates of trajectory group membership in a sample of 386 adjudicated youth in Ontario. Study participants had served a sentence at one of two open custody facilities in Toronto, between 1986 and 1997. Criminal offending, based on official records, was tracked for 16.4 years, on average (*SD* = 4.1, range = 9.8 – 28.7 years), from late childhood/early adolescence into their early 30s, on average. Childhood and adolescent factors reflecting individual, family, peer, and school domains were extracted from client files. A seven-group model best fit the sample. Results of the multinomial regression analyses indicated that antisocial behaviour and poor academic achievement in childhood and poor family relations, involvement in alternative care, and poor academic achievement in adolescence differentiated the low rate desister trajectory from the high and moderate rate offence trajectories. Implications for identifying children and youth at risk for high rate persistent offending to target in prevention and early intervention programs are discussed.

Keywords: group-based trajectory analysis; juvenile offenders; risk factors; high rate chronic offenders; early intervention; prevention

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It has long been recognized that a small proportion of individuals are responsible for a disproportionate number of crimes. Wolfgang, Figlio and Sellin (1972) reported that 6% of their Philadelphia cohort accounted for 50% of the criminal acts to age 17. More recently, Welsh, Loeber, Stevens, Stouthamer-Loeber, Cohen, and Farrington (2008) found that 10.2% of their sample from the Pittsburgh Youth Study (PYS) accounted for 50.1% of all self-reported offences. This small collection of high rate habitual offenders often begins their criminal activity at an early age and continues into adulthood, commits serious and violent crimes, imposes considerable financial costs on society, and poses a significant challenge to the criminal justice system (Cohen, Piquero, and Jennings, 2010; Piquero, Farrington, and Blumstein 2003). Therefore, targeting early intervention and prevention programs for children and youth likely to become chronic offenders is an important task for our society that makes good economic sense and holds the greatest promise for crime reduction (Alltucker, Bullis, Close, and Yovanoff, 2006; Aos, Phipps, Barnoski, and Lieb 2001; Craig, Schumann, Petrunka, Khan, and Peters, 2011).

Using data from the Second Philadelphia Birth Cohort (Tracy, Wolfgang, and Figlio 1990), Cohen et al. (2010) estimated that the financial burden of the small group of high rate chronic offenders identified in their study (3.1% of the sample) was nearly half the total cost of offending for the entire sample. Moreover, emerging evidence suggests that the greatest gains from crime prevention efforts come from targeting those individuals with the highest risk factors (Dodge and McCourt 2010; Welsh and Farrington 2007). This was the conclusion reached by Foster, Jones, and the Conduct Problems Prevention Research Group (2006) when they evaluated the cost-effectiveness of the Fast Track prevention program for at-risk children in first through

tenth grade. Using incremental cost-effectiveness ratios (ICERs), an index of the costs of the program relative to the outcomes, they determined that, for the group at lowest risk at intake, the ICER was negative and the effectiveness probability was 6%, indicating that the program was neither cost effective nor likely to be effective with this group. By contrast, for the group at highest risk at intake (defined as those above the 90th percentile on the screening measures), the estimated ICER was found to be $752,103 (less than the $1 million threshold) and the effectiveness probability was 99%, indicating both cost-effectiveness and a high likelihood of being effective with this group.

Across Canada, many child- and youth-serving agencies engage in early intervention and prevention programs for crime prevention. A challenge for any targeted (i.e., indicated or selected) prevention or early intervention program is to identify those individuals most at risk of the maladaptive outcome, such as a life of crime (Cohen et al. 2010; LeBlanc 1998; Lochman 2006). Considerable efforts have been expended over the past decades to identify factors that are most strongly associated with the onset and maintenance of criminal behaviour (Leschied, Chiodo, Nowicki, and Rodger 2008; van Dombrgh, Vermeiren, Blokland, and Dorelejiers, 2009). These efforts have informed the development of myriad programs for young people aimed at preventing or forestalling the onset of antisocial activity by strengthening protective factors and reducing the impact of risk factors, some of which have been shown to be effective (Farrington 2007). However, further work needs to be done to identify individuals who show risk factors associated with the most serious, protracted, and highest rate criminal careers.

Our framework for understanding the nature and course of offending comes from the risk factor research (RFR) and developmental and life course (DLC) paradigms advanced by Farrington (2003, 2005a), which are concerned with identifying and investigating linkages

between past events (i.e., risk factors) and future outcomes. Consistent with these approaches, longitudinal studies that track criminal activity over time, ideally across major developmental periods such as adolescence and adulthood, that are able to identify, prospectively or retrospectively, early risk factors associated with serious (i.e., high rate, persistent) offending could aid the development of targeted intervention and prevention strategies. Longitudinal studies have the advantage over other methodologies such as cross-sectional research of tracking within-individual developmental pathways and of identifying how life events are associated with change and continuity across the life course. Moreover, recent advances in person-centered statistical analyses have enabled longitudinal researchers to examine within-individual change over time as well as to identify distinct patterns of within-sample offending behaviour (i.e., age-crime trajectories).

One of these statistical techniques is the group-based trajectory analysis (Nagin 2005). Group-based trajectory analysis is a specialized application of finite mixture modelling (McLachlan and Peel, 2000) that allows the researcher to identify clusters of individuals whose pattern of offending is statistically similar as it unfolds over time. Furthermore, consistent with the classify/analyze paradigm (Piquero, 2007; Roeder, Lynch and Nagin, 1999), once individuals are sorted into discrete trajectory groups, regression analysis (or other statistical approaches) may be applied to identify the best set of developmental predictors that differentiates the groups (Nagin and Odgers, 2010a). Childhood and adolescent variables, reflecting various life domains (e.g., individual, family, peer, school, and neighbourhood), are recorded, which are then subjected to the analysis. In this regard, group-based trajectory analysis may be well-suited to identify risk factors that could inform the development of targeted early intervention and prevention programs (Chung, Hill, Hawkins, Gilchrist, and Nagin, 2002; Cohen et al. 2010;

Piquero, Paternoster, and Brame, in press; Wiesner and Capaldi, 2003)[1]. This position reflects the influence of both the DLC and the risk factor research (RFR) paradigms. However, the point is not without controversy as some evidence suggests that trajectory analysis may not be so useful for this purpose (Bersani, Nieuwbeerta, and Laub, 2009; Sampson and Laub, 2003; Skardhamar, 2010). The next section briefly reviews the literature on group-based trajectory analysis.

Findings from group-based trajectory analyses

The criminology field has widely embraced group-based trajectory analysis since its advent about 20 years ago (Nagin and Odgers, 2010b). Piquero (2008) identified over 80 studies that have used these statistical techniques. As a review of all these studies is beyond the scope of this paper, select findings will be highlighted with a particular emphasis on risk factors associated with the most serious offence trajectories. Across studies, the number of trajectory groups yielded varies from as few as two (Yessine and Bonta 2009) to as many as eight (Thornberry 2004), though four to six is typical (Piquero, 2008). Reasons for differences in the number of trajectory groups include sample characteristics, methodological design, the number of time points for assessment, and outcome variable definition.

Comparisons across trajectory groups on offending-related variables indicate that groups differ in terms of the average age of onset, length of the criminal trajectory, peak age of offending, and number of offences committed. Moreover, studies with community samples commonly identify a nonoffender group, which often comprises the majority of individuals in the sample (e.g., Piquero, Farrington, and Blumstein 2007). Studies with offender samples typically identify a low rate (e.g., near-zero) trajectory group, which often comprises the largest group in

the sample. For example, Bersani et al. (2009) found that 70% of their offender sample fell into the lowest rate group (referred to as "sporadic offenders").

In addition to identifying a nonoffender or low rate group, the other end of the trajectory group spectrum reports a high rate trajectory group that shows persistence in their offending. These high rate chronics (as they are typically labeled) generally constitute about 10% of the sample, irrespective of sample characteristics. There is now a growing body of literature that has examined risk factors[2] of these trajectory groups. As noted, this literature might prove useful in identifying early predictors of high rate persistent offenders, for whom targeted early intervention and prevention programs might be developed, as well as the particular risk and protective factors that could be targeted by the intervention.

Twenty studies were identified that examined both trajectory groups and risk factors of trajectory group membership. With regard to the relations between risk factors and trajectory groups, some studies have reported dose effects such that high rate groups evince the most risk factors, low rate groups show the most favourable backgrounds, including the most protective factors, and moderate rate groups fall somewhere in between (e.g., Fergusson, Horwood, and Nagin, 2000; Maldonado-Molina, Piquero, Jennings, Bird, and Canino 2009; Sampson and Laub, 2003; van Domburgh, Loeber, Bezemer, Stallings, and Stouthamer-Loeber 2009). Other studies have not reported dose effects but rather reported on differences for discrete variables such that specific risk factors were associated with particular trajectory groups (e.g., Ward, Day, Bevc, Sun, Rosenthal, and Duchesne 2010; Wiesner and Windle 2004). Table 1 summarizes the specific risk factors associated with serious offence trajectories. Identified risk factors were those that were unique to the high rate chronic group and were distinguished from the low rate or nonoffender group, such as identified through a multinomial regression analysis in which the

reference group was the low rate or nonoffender group (cf. Wiesner and Windle 2004; Wiesner and Capaldi 2003 who used their high rate group as the reference group). These comparisons were often the most robust with regard to finding group differences, although such comparisons (i.e., of extreme groups) also will lead to an overestimation of the strength of the relationship for that risk factor (Farrington 2005b).

Insert Table 1 about here

As presented in Table 1, high rate chronic offenders comprised between 3.1% and 27.0% of the samples[3]. Examination of the risk factors of the high rate chronic group indicate that a range of developmental factors falling across a number of domains (i.e., individual, family, peer, school, and environmental) characterize individuals on the most serious offence trajectory. Individual risk factors included early conduct problems and attention problems, aggressive behaviour, older age at first offence, adjustment problems, male gender, sensation seeking, depression, suicidality, substance abuse/dependence, risky sexual behaviour, psychosocial immaturity, Indigenous status, and non-Western ethnic background. Family factors included family adversity, authoritarian parenting, poor parental monitoring and supervision, low parental empathy, negative labels applied by the parents to the child, family contact with a child welfare agency, and criminal family members. Peer factors included association with a delinquent or deviant peer group and high peer tolerance of deviance. The school factor was poor academic achievement. Environmental factors included social disadvantage, exposure to community violence, and availability of drugs.

Although drawing firm conclusions from this diverse body of literature is difficult due to differences in sample characteristics, length of follow-up, nature of criminal data gathered, and so forth, it is evident that no single risk factor or set of risk factors clearly emerges as the most salient predictor of high rate chronic offending. Rather, a range of factors from several domains contributes to the emergence of high rate chronic offending. This is consistent with the concept of equifinality (Cicchetti and Rogosch 1996). Note that the findings summarized in Table 1 reflect, to some extent, the particular theoretical focus of the study or the number of risk factors and life domains included in the analyses. For example, whereas some studies examined a broad range of risk factors that relate to multiple life domains (e.g., Chung et al., 2002; Piquero, Farrington, and Blumstein 2007; van der Geest, Blokland, and Bijleveld 2009; Ward et al. 2010; Wiesner and Silbereisen 2003), other studies focused on a narrow range of variables or had a limited theoretical focus (e.g., Hoeve, Blokland, Semon Duas, Loeber, Gerris, and van der Laan 2008; Monahan, Steinberg, Cauffman, and Mulvey 2009).

Moreover, consistent with developmental theories of antisocial behaviour (e.g., Patterson, DeBaryshe, and Ramsey 1989; Moffitt 1993; Thornberry, 2005), these factors are thought to exert their influence at different stages of development. For example, Chung et al. (2002) asserted that the effect on serious criminal offending of family adversity experienced in childhood would be mediated through peer, school, and neighbourhood factors in adolescence. In other words, the impact of distal factors would be mediated by variables more proximal to the event (i.e., the criminal behaviour). Moreover, Wiesner and Capaldi (2003) reported that family factors in childhood, specifically punitive and inconsistent parenting and low parental supervision, and deviant peer associations in adolescence were both uniquely associated with a chronic, high level offence trajectory. They interpreted this pattern of results as suggesting that,

whereas family factors in childhood were associated with the onset of criminality in the chronic high level group, peer factors in adolescence were associated with the maintenance of this offence trajectory. A prominent theory to account for developmental differences in offending among young people is Moffitt's (1993) dual taxonomy theory. Taking a biosocial approach, Moffitt asserted that youth criminality has its onset either in childhood or adolescence and that different factors are implicated in the initiation and maintenance of the antisocial behaviour. The early starters, that is the life-course persistent group (LCP), experience considerable early risk factors, including neurological problems that interact with aversive environmental conditions to yield a life-long, highly stable pattern of delinquent behaviour. The late starters, that is, the adolescence-limited group (AL) experience relatively normal development until about age 15, at which time a striving for personal independence leads them to mimic the antisocial lifestyle of their delinquent counterparts. For this group, the increasing influence of the peer group during adolescence, alongside the concomitant social-emotional, cognitive, and physical changes, provides the impetus for the antisocial behaviour.

Although these studies are important to identify the early risk factors of those who set upon a serious and protracted criminal trajectory, there is still a need for more research, particularly with Canadian samples, given the paucity of investigations done in this country. This is particularly important if research is to be of value to inform the development of targeted prevention programs for Canadian at-risk children and youth. Second, additional studies are needed that follow individuals across developmental periods to shed light on the change and continuity of offending beyond the peak period of offending in adolescence. The present study aims to examine the developmental predictors/correlates of individuals classified into distinct trajectories in a Canadian sample of male offenders whose criminal trajectories were followed

across the developmental period of adolescence into adulthood. The developmental factors reflect a wide range of variables from both childhood and adolescence across four life domains (individual, family, peer, school). Consistent with previous research, we expected individuals on a high rate persistent trajectory to evince the most predictors/correlates across the four domains.

METHOD

Sample

The study sample comprised 386 male offenders who had served a youth sentence between 1986 and 1997, at one of two open custody facilities operated by a children's mental health centre in Toronto. This sample represents a 50% random selection of all youth who had been sentenced to the two facilities during this period. Results for the other half of this population are described in Ward et al. (2010).

Criminal data

Official records for juvenile and adult offences were obtained from the (Ontario) Ministry of Correctional Services (MCS), the Canadian Police Information Centre (CPIC), and Predisposition Reports (PDR) from the client files maintained by the children's mental health centre. Three data sources were used to ensure a high degree of completeness and accuracy for the sequenced, longitudinal offending data, which is essential for research that requires an accurate temporal sequencing of criminal activity (Smith, Smith, and Norma, 1984). Official records were appropriate for our purposes because they provided the requisite precision with regard to both the timing and sequence of offending as well as offenders' movement data into and out of the custody settings.

From these sources, counts by age of all their unique court contacts arising from a new set of charges[4] were recorded to September 26, 2007, the end of the follow-up period. The

criminal count data were adjusted for both time-at-risk (Eggleston, Laub, and Sampson 2004) and estimated age at the time of offence rather than at court contact (Farrington, Coid, Harnett, Jolliffe, Soteriou, Turner, and West 2006). The time-at-risk adjustment involved dividing each count y_{ij} by the corresponding exposure time t_{ij} and rounding the result to the nearest integer (truncated at a maximum of 25). For the age adjustment, we modelled the time lag as a random unknown quantity, following an exponential distribution, whose mean value of 157.6 days was estimated from supplementary data obtained from the Metropolitan Toronto Police Service (MTPS) (see Day, Bevc, Duchesne, Rosenthal, Rossman, and Theodor 2007 for details on these adjustments).

The criminal activity for this sample was tracked for an average of 16.4 years (*SD* = 4.1, range = 9.8 – 28.7 years), from late childhood/early adolescence[5] into adulthood. Their mean age at first court contact was 15.6 years (*SD* = 1.6) and the sample was 32.0 years (*SD* = 4.0, range = 26.3 – 40.2 years) at the end of the follow-up period. The average trajectory length, defined as the difference in years between the first and last court contact, was 9.5 years (*SD* = 5.6). During the tracking period, the sample accumulated a total of 4,657 court contacts, an average of 12.1 court contacts per individual.

Predictors/correlates

Personal and background information was extracted from client files maintained by the children's mental health centre that operated the open custody facilities. Of a possible 386 client files, 349 files were reviewed and coded. The remaining 37 files could not be located, possibly due to lost or incomplete files or an alternative storage location. Documents that were reviewed for coding included intake forms, PDRs, psychological and psychiatric reports and notes,

discharge summaries, and other pertinent sources of information on file such as case notes, social work reports, and police synopses.

In order to differentiate the childhood (i.e., birth to 12 years) from adolescent (i.e., 13 to 19 years) variables, two sets of coding schemes were developed, one for each developmental period. The coding schemes were designed to include as much relevant information from the client files as possible[6]. Selection of the variables was based on a comprehensive review of the theoretical and empirical literature and reflected four life domains: individual, family, peer, and school. The coding schemes were essentially the same as those used in Ward et al. (2010), with the addition of four variables (noted below).

In the individual domain, variables included hyperactivity-impulsivity-inattention, antisocial behaviour, alcohol and/or drug use, callousness, lack of responsibility or accountability for bad behaviour, health problems, low self-esteem, and extra-familial sexual abuse, immigrant status, death of a caregiver, homelessness, and suicidality (the latter four items were added for this study). In the family domain, variables included criminal family members, parental psychopathology, poor child-rearing methods, family abuse, relationship difficulties among family members, broken home/family transitions (e.g., parental separation or divorce, change in caregivers, frequent moves), involvement with alternative care (e.g., institutional or foster care, child welfare), and if the biological mother was age 17 years or younger at the time of childbirth. The peer domain included one variable, poor peer relations (i.e., peer rejection, antisocial peer associates). The school domain included two variables, poor academic achievement and poor regard for school (i.e., truancy, expulsions, and suspensions). Although the childhood and adolescent coding schemes overlapped on most items, there were some areas of divergence. For example, only the childhood coding scheme included the item of whether the biological parent

was under the age of 17 at the time of the offender's birth and only the adolescent coding scheme included the items concerning callousness, lack of responsibility for bad behaviour, homelessness, and suicidality. Coding for the developmental variables was dichotomous, such that 0 = "absent/unknown" and 1 = "present/suspected."

The coding was conducted by a research assistant who was unaware of the trajectory group membership assignments. Inter-rater reliability was conducted by two independent raters using 20 files, representing a 5.6% randomly selected sample of files. Inter-rater reliability was found to be moderate to good (Landis and Koch 1977) with average Kappas of .77 for the childhood variables and .70 for the adolescent variables.

Data analysis

The data analysis proceeded in three stages. First, using *crimCV*, a software program we developed for our research program (Nielsen, Rosenthal, Sun, Day, Bevc, and Duchesne, 2011)[7], we fit the data with a latent class zero-inflated Poisson (ZIP) model with different numbers of K classes. A ZIP (Lambert, 1992) model using the so-called ZIP (τ) parameterization was used for the latent sub-populations to account for the relatively large number of zero court contacts in the data set. Conditional on an individual being a member of class k the expected number of criminal events μ_j^k at age j is given by

$$\mu_j^k = \left(1 - q_j^k\right)\lambda_j^k$$

where

$$\log\left(\frac{q_j^k}{1 - q_j^k}\right) = -\tau^k \log\left(\lambda_j^k\right)$$

with q_j^k being the probability of individuals in class k being criminally inactive at age j and

$$\log\left(\lambda_j^k\right) = \beta_0^k + \beta_1^k j + \beta_2^k j^2 + \beta_3^k j^3$$

with λ_j^k the rate of court contacts for an individual in group k and criminally active at age j. All parameters **θ** were estimated by the method of maximum likelihood under the assumption that, within the trajectory groups, the number of court contacts of those in a criminally active state at age *j* followed a nonhomogeneous Poisson process with rate parameter λ_j^k (Jones, Nagin, and Roeder 2001). Trajectory group membership was based on the highest individual posterior probability associated with each trajectory group.

Selection of the number of groups that best fit the data is conventionally based on the Bayesian Information Criterion (BIC). However, it is known that the BIC provides a somewhat problematic solution to the number of groups issue (Nagin 2005). As an alternative method, we used cross-validation (Hélie 2006; Stone 1974), specifically, *leave-one-out cross-validation.* This method provides a fair, objective, and unambiguous means of assessing the number of groups and avoids the limitations, ambiguities, and subjectivity that may arise with the BIC (Day et al., 2007). The cross-validation measures the accuracy of the fit for individual *i* by using estimates of the model parameters $\theta^{(-i)}$ based on data for all the *other* individuals but not individual *i* for all observed subjects. This approach validates the model by assessing its ability to predict observed data values using the remaining data. The advantage of cross-validation is that it provides a fair measure of how appropriate the chosen group number K is for the given data, in terms of how accurately a model with that number of groups is able to predict the offender data. A large cross-validation error (CVE) indicates that the model with K groups is not a good statistical model for this data. A small CVE indicates the model with K groups is doing a good job of predicting offender data. The cross-validation criterion for number of groups then involves simply choosing the value of K that minimizes CVE.

Next, given the large number of predictors/correlates, a two-step approach eliminated variables for entry into the multinomial regression analyses. First, variables were excluded that had either a base rate of 10% or less or zero cell counts across the trajectory groups. Second, following the procedure outlined by Hosmer and Lemeshow (2000), each of the remaining variables was entered into a univariate multinomial regression analysis to assess its appropriateness in the model. This was done by examining the impact of the presence and absence of each factor on the overall goodness-of-fit and chi-square Likelihood Ratio Test (LRT) statistic**.** Following the recommendation of Hosmer and Lemeshow, a variable was retained for inclusion in the analyses if the corresponding chi-square LRT statistic reached $p < .25$. Last, backward stepwise multinomial logistic regression analyses were performed on the final set of background variables to determine the relationship between the best combination of factors and the trajectory groups. Backward stepwise regression is a useful procedure when important factors have not been identified and when the association between the risk factors and outcome variables are not well understood (Hosmer and Lemeshow 2000). SPSS 17.0 was used for the regression analyses.

RESULTS

Trajectory analysis

As indicated in Table 2, the BIC and AIC values continued to increase as the number of groups increased. Hence, the BIC and AIC criteria both suggest at least an eight-group model and probably even more groups; for more than eight groups, the amount of computation required to fit the model and calculate the CVE is very high. However, the CVE was minimized for the seven-group model. Therefore, the cross-validation criterion clearly recommends choosing $K = 7$. Model-fit statistics support this decision. The mean posterior probability coefficients (AvePP)

exceeded .90 for all seven trajectories, which was higher than the recommended threshold value of .70 (Nagin, 2005) and suggests there was little ambiguity in grouping individuals with similar trajectories and discriminating between individuals who show dissimilar trajectories. The odds of correct classification (OCC) provided further evidence to support the seven-group model with OCC values for the groups ranging from 20.70 to 11099.24, exceeding the minimum recommended threshold of 5.0 (Nagin, 2005). Last, although the estimated group membership probability for three of the seven trajectories was lower than 5%, this was seen as acceptable in studies that use clinical samples (Andruff, Carraro, Thompson, Gaudreau, and Louvet, 2009)[8]. Once we fix $K = 7$, we can then identify the most likely probability-based group membership for each subject. The analysis identified seven bell-shaped trajectories with varying peaks, rates, and trajectory lengths. The estimated criminal trajectories are displayed in Figure 1. Offence-related information for each group is presented in Table 3.

For ease of reporting, we used the following heuristic labels to describe the trajectories. First, the *moderate late persister* group, the least prevalent trajectory (3.6%), had the longest average trajectory length and the latest peak age of offending of all the trajectory groups. Second, the *high late* group had the highest average rate of court contacts (adjusted for time-at-risk) and a peak age of offending in their mid 20s. Moreover, this group comprised only 3.9% of the sample but accounted for 15.8% of the total number of court contacts incurred by the sample. Third, the *high early* group had the second highest rate of offending and a peak age of offending in their early 20s. The fourth trajectory, labeled the *moderate adolescence-peaked* group, showed a peak age of offending in early adolescence and an average trajectory length of 10.2 years. Fifth, the *moderate early persister* group had the second longest average trajectory length, up to age 30.1 years, on average, and a peak age of offending in their early 20s, earlier than the

moderate late persister group. Sixth, the *low desister* group, comprising 29.8% of the sample, had the shortest average trajectory length and the fewest average number of court contacts, accounting for only 7.4% of the total court contacts incurred by the sample. Finally, the *low persister* group comprised 32% of the sample and had an average trajectory length of 11.1 years, to age 27 years, on average[9].

Insert Tables 2 and 3 about here

Insert Figure 1 about here

Cross-tabulation results

Presented in Tables 4 and 5 are the prevalence rates for the childhood and adolescent predictors/correlates across the seven groups. These data suggest that, in childhood, the high early group was overrepresented on the family abuse variable (46.7%), followed by the high late (33.3%) and moderate adolescence-peaked (33.3%) groups. In adolescence, the high early group was overrepresented on four variables: hyperactive impulsivity-inattention (86.7%), family abuse (40.0%), involvement in alternative care (46.7%), and poor academic achievement (60.0%). The moderate late persister group also showed a high prevalence rate on the poor academic achievement variable (53.8%). Last, the moderate adolescence-peaked group was overrepresented on the family relationship problems variable (71.8%), followed by the high late (66.7%) and moderate early persister (51.0%) groups.

Insert Tables 4 and 5 about here

Multinomial logistic regression analyses

Childhood model. Based on the aforementioned criteria for variable selection, five childhood predictors were entered into the multinomial logistic regression model: antisocial behaviour, poor child-rearing methods, family abuse, broken home/family transitions, and poor academic achievement. The overall model was significant (χ^2 (12) = 23.95, p = .021) with antisocial behaviour and poor academic achievement significantly contributing to the model (both ps < .05). The proportion of variance in trajectory group membership, as measured by the Nagelkerke pseudo R^2 statistic, was 6.9%. In order to determine the predictors that distinguished low desisters from more active and persistent offending, the low desister trajectory was the base reference group.

The results are presented in Table 5 and indicated that an early onset of antisocial behaviour predicted the high late and moderate adolescence-peaked groups, in comparison to the low desister group. More specifically, the presence of early antisocial behaviour increased by a factor of 4.2 (p = .029, 95% CI [1.16, 15.01]) and 3.4 (p = .003, 95% CI [1.49, 7.51]) the risk of being in the high late and moderate adolescence-peaked groups, respectively, compared to the low desister group. As well, poor academic achievement decreased by a factor of .36 the risk of being in the moderate adolescence-peaked group, compared to the low desister group (p = .043, 95% CI [0.13, 0.97]).

Insert Table 5 about here

Adolescent model. Based on our criteria for variable selection, five adolescent correlates were entered into the multinomial logistic regression model: hyperactivity-impulsivity-inattention, antisocial behaviour, family relationship problems, involvement with alternative care, and poor academic achievement. The analysis yielded a significant model (χ^2 (18) = 57.97, p = .001) comprised of three significant factors, family relationship problems (p = .001), involvement with alternative care (p = .002), and poor academic achievement (p = .001). The proportion of variance in trajectory group membership accounted for by these three factors, as measured by the Nagelkerke pseudo R^2 statistic, was 15.9%. Once again, the low desister group was designated as the base reference group.

The results are presented in Table 6 and indicated that family relationship problems predicted membership in the high late, moderate adolescence-peaked and moderate early persister groups, compared to the low desister group. More specifically, experiencing relationship problems among family members increased the risk of being in the high late, moderate adolescence-peaked, and moderate early persister groups by a factor of 4.0 (p = .038, 95% CI [1.08, 14.69]), 5.2 (p = .001, 95% CI [2.26, 12.14]), and 2.1 (p = .043, 95% CI [1.02, 4.21]), respectively, compared to the low desister group. As well, involvement in alternative care increased by a factor of 4.4 (p = .029, 95% CI [1.17, 16.80]), 3.4 (p = .043, 95% CI [1.04, 11.32]), and 3.9 (p = .003, 95% CI [1.58, 9.57]), the risk of being in high late, high early, and moderate adolescence-peaked groups, respectively, compared to the low desister group. Last, poor academic achievement decreased by a factor of .23 (p = .047, 95% CI [0.05, 0.98]), .20 (p = .001, 95% CI [0.08, 0.51]), and .35 (p = .011, 95% CI [0.16, 0.79]), the risk of being in the high late, moderate adolescence-peaked, and moderate early persister groups, respectively, compared to the low desister group.

Insert Table 6 about here

DISCUSSION

Using data from an offender sample of Ontario youth, group-based trajectory analysis and multinomial regression examined age-crime trajectories and predictors/correlates of trajectory group membership. The results of the trajectory analysis yielded a model with seven trajectories, reflecting the considerable heterogeneity in their offending rates over the duration of the follow-up period. Despite this being an offender sample, the majority of individuals were in two low rate trajectory groups, whose offending rarely reached more than one unique court contact in a given year, even after adjusting for time-at-risk due to periods of incarceration. Like other studies (e.g., Marshall, 2006; Piquero et al., 2007), we also identified one low rate group that had a very brief criminal trajectory and one low rate group that had a much longer period of criminal activity.

Moderate rate offenders, located on three separate trajectories, made up nearly a third of the sample. One of the moderate rate groups showed a peaked age of offending in early adolescence, whereas the remaining two trajectories both peaked in adulthood and persisted in their offending, evincing both the longest and second longest trajectories in the sample. The lengthy criminal careers of these moderate rate offenders should be of concern to the criminal justice system. They appear to be holding firm to a criminal lifestyle, though not offending at high rates. We had surmised previously (Ward et al., 2010) that moderate rate offenders may be more likely to experience such psychosocial problems as substance use and abuse issues, low levels of social support, and maladaptive coping that entrap them within the criminal lifestyle.

These could be targets for intervention by the justice system, through both institution-based and community-based services. Last, less than 10% of the sample was found to be in the two high rate offence trajectory groups.

With regard to trajectory lengths, with the exception of the low desister group, which had a trajectory length of only 3.1 years, all the trajectory groups continued their criminal activity into their mid 20s or 30s, with criminal career lengths exceeding 10 years from their first court contact in their mid teens. This was to be expected, as Piquero (2008) reported that offence trajectories typically show a gradual decline by the mid 30s. As the average age at the end of the follow-up of this study was 32 years, many in the sample may have "matured" out of their offending, although further follow-ups will likely show continued criminal activity for the small number of persistent offenders (Bersani et al. 2009).

Results of the univariate and multivariate tests revealed that, overall, only a few predictors/correlates factors differentiated the low desister group from the remaining six trajectories. In childhood, two variables differentiated the high late and moderate adolescence-peaked groups from the low desister group, early antisocial behaviour and poor academic achievement. In adolescence, two family factors and one school factor differentiated the high late, high early, moderate adolescence-peaked, and moderate early persister trajectories from the low desister group, family relationship problems, involvement in alternative care, and poor academic achievement. That poor academic achievement emerged as a risk factor for the low desisters was an unexpected finding and not consistent with the research (Wiesner and Windle, 2004). Inspection of the cross-tabulations tables suggests that exposure to at least one risk factor was evident among a substantial portion of individuals in the sample, across all the offence trajectories. For example, a broken home in childhood was experienced by no less than 43.8% of

individuals in each trajectory group, including the low rate desisters. In adolescence, the prevalence rates were generally higher across the variables. This can be seen, for example, for antisocial behaviour, alcohol and drug use, and poor peer relations. Clearly, no group was immune from the presence of some developmental risk factors. However, as all the individuals in the current study had served a sentence at a facility operated by a children's mental health sentence, with its greater access to counseling staff and treatment programs, they may not have been representative of all juvenile offenders in custodial settings during the period between 1986 and 1997. This would limit the generalizability of the findings.

The larger number of variables in adolescence that reached statistical significance is consistent with the meta-analysis by Leschied et al. (2008). These authors found that adolescent risk factors tend to be stronger predictors of adult criminal offending than childhood risk factors. Indeed, Tackett (2010) noted that risk factors experienced early in life may result in general rather than specific risks for the individual, consistent with the phenomenon of multifinality (Cicchetti and Rogosch, 1996). Indeed, some research suggests that risk factors experienced early in life, for example, during the prenatal and perinatal periods of development, confer the most detrimental effects over the life span (Lussier, Healey, Tzoumakis, Deslauriers-Varin and Corrado, 2010). These risk factors include maternal substance use and birth complications, but also include abuse and neglect experienced in the first five years of life (Osofsky and Lieberman, 2011). The relation between distal and proximal variables is thought to involve a meditational effect, such that the impact of a distal variable on an outcome is not so much "'called forth' from the distant past" (Sampson, 2001, p. vi; see also Lösel and Bender, 2003) as much as mediated by proximal influences. In this regard, distal and proximal risk factors are thought to operate as part of complex developmental causal chains to influence outcomes. For example, the relation

between early antisocial behaviour and later family discord, characterizing the high late group, may suggest a developmental progression from childhood to adolescence described by Corrado and Freedman (2011) in their second hypothetical pathway to offending.

The implication is that prevention should begin as early as possible and that effective programs could yield positive effects across multiple areas of a person's life (Farrington, 2007). The policy implication is that the expected benefits of early intervention programs to promote optimal growth and development would be broader than a reduction in crime, for example, in terms of social competence, emotional and behavioural self-regulation, and school readiness. Programs designed specifically to address crime may focus on more proximal variables, such as school transitions, precocious substance use, familial abuse and other relation problems, and early delinquent peer associations.

Finally, although not the most persistent trajectory in the model, in partial support of our prediction, individuals on the high late trajectory showed the most developmental predictors/correlates across two domains, early antisocial behaviour problems, family relation problems, and involvement in alternative care. This would suggest that, as a group, the small number of individuals on this high rate trajectory experienced the greatest adversity in childhood and adolescence within the individual and family domains. This would lend some support to the notion that crime prevention efforts will be most effective when targeted towards groups that show the most developmental risk factors (i.e., a dose effect).

Future research should attempt to understand the causal mechanisms linking these risk factors to criminal outcomes. For example, the significant effect for involvement with alternative care replicates our previous findings with a different sample from the same population of offenders (Ward et al., 2010) and accords with a growing body of literature that highlights this

life circumstance as an important risk factor for later criminality (Leschied et al., 2008; Nicol, Stretch, Whitney, Jones, Garfield, Turner, and Stanion 2000; Ryan and Testa 2005). Additional research is needed to fully understand the developmental processes involved in the life experiences associated with child welfare involvement that would either create its own risk factor or exacerbate existing risk factors, for later contact with the justice system (Corrado, Freedman, and Blatier, 2011). Some researchers (Alltucker et al., 2006; Ryan, Hernandez, and Herz, 2007) have suggested that limited educational opportunities, placement instability, unreliable or nonexistent support from family, and low-wage employment contribute to the difficulties foster care youth encounter as they exit the system, which further increases the likelihood they will become involved in the justice system. At the same time, Ryan et al. noted that not all foster care youth have contact with the justice system. Their trajectory analysis indicated that 52% of the sample was identified as nonoffenders. These individuals were more likely to be in school than those who had criminal offences. Consistent with a DLC perspective, further investigations could examine the developmental risk factors associated with family breakdown and child maltreatment that initiate a pathway to child welfare involvement, program instability, poor academic achievement, and other challenges facing dependent youth in order to better understand the mechanisms underlying the child welfare-delinquency link (Alltucker et al., 2006; Ryan et al., 2007; Ryan and Testa, 2008). This research could then inform the development of support systems, to assist youth as they transition out of foster care, and programs that help children and youth experience educational success while in the care of the child welfare system.

Limitations

The present study had a number of limitations. First, the study was limited by problems inherent in any archival file review study. The study findings reflect the amount and quality of information that was accessible in the client files. Much of the childhood data, for example, came from retrospective accounts by key informants contained in the PDRs, documents that are prepared for the courts. Only the most salient factors may have received attention in these reports, with less salient, but nonetheless equally important (i.e., in terms of explanatory power), factors given less attention. Second, the developmental variables were coded as either "absent/unknown" or "present/suspected." Whether a factor was absent because the youth had not experienced it or because the factor was not mentioned in the documents on file could not be confirmed.

Third, the limited information available in the client file reviews and the exploratory nature of our study did not allow for a test of causal hypotheses about the processes leading to offending behaviour, as suggested by current developmental theories (see also Davis, Banks, Fisher, and Grudzinskas, 2004). In this regard, it is important for future research to examine the complex, causal processes or mechanisms by which risk and protective factors exert their influence on the development and course of offending behaviour (Farrington 2007). Fourth, although our coding scheme included both risk and protective factors, the low base rate of occurrence of the protective factors precluded their examination in the analyses. Fifth, our criminal data were based on official records, though from multiple sources, and may have underestimated the full extent of the participants' criminal activity by not including less serious offences and/or offences that may not have come to the attention of the authorities. Last, our trajectory analysis was conducted using our own software program, *crimCV*, written in the R programming language, that aimed to improve upon some of the limitations of the conventional

methods used in the literature (e.g., use of the BIC for model selection) based on alternative approaches (Hiele, 2010). As a result, comparisons with other studies should be made with this in mind.

The above limitations notwithstanding, this study contributes to the literature on trajectory analyses of criminal offending by identifying childhood predictors and adolescence correlates associated with offence trajectories in a Canadian-based sample of offenders. Early conduct problems was associated with a high late offence trajectory, in agreement with considerable theory and research. Family relationship problems and involvement in alternative care also were associated with this small group of serious offenders. Given the imposing costs associated with high rate chronic offenders (Cohen et al., 2010), a next step is to translate the body of risk factor research into theoretically-sound policy frameworks to inform the development of prevention and early intervention strategies to address the diversity of needs that reflect the multiple pathways that lead the highest risk children and youth into a life of crime.

NOTES

[1]A word of caution is warranted however, about moving in too quickly to do "something to people *predicted to be* high-rate offenders" (Piquero 2008: 52). Risk factors are meant to be understood as probabilistic not deterministic. Furthermore, there is the danger of reifying groups generated by a statistical procedure and acting upon them as if they were real entities. Last, risk-focused interventions and prevention strategies that are based on sound theoretical models, framed within a developmental and life course perspective (Farrington 2005a), offer both the greatest likelihood of effectiveness as well as the ability to test causal models of development, thereby contributing to the advancement of the growing field of prevention science (Lochman 2006).

[2]Although the term risk factor refers to a variable for which temporal precedence with the outcome has been established, for ease of discussion, this term will be used to refer to both predictors and correlates except when referring to variables in the present study.

[3]Across studies, although common labels are applied to trajectory groups that show the highest levels of offending and/or the longest offence trajectories, these groups are likely qualitatively different from each other due to differences in sample characteristics, type of criminal data used, length of follow-up, age of sample over the follow-up period, and whether a time-at-risk adjustment was applied, which, of course, has the largest impact on the high rate chronic groups because of the greater likelihood of incarceration. As a result, the term *high rate chronic*, is meant to be understood as relative rather than absolute and comparisons across studies need to be made with caution.

[4]Unique court contacts included those that resulted in a conviction and disposition (e.g., secure or open custody, fine, etc.), including a suspended sentence; those that resulted in a finding of

guilt but not a conviction (e.g., absolute or conditional discharge); and those that resulted in either a withdrawal of charges, stay of proceedings, or determination that the person was unfit to stand trial (e.g., due to cognitive competence). These latter types of court contacts, which involved neither a finding of guilt nor a conviction, only accounted for 6.5% of the total number of court contacts. Last, for 8.0% of the court contacts, the final status in the official records was "remand," and, as such, no specific outcomes were available.

[5]Offences committed under the age of 12 years were charges that occurred under the Juvenile Delinquents Act (JDA). Only nine court contacts occurred under the JDA and took place between 1979 and 1983. The remaining juvenile court contacts occurred under the YOA.

[6]The coding schemes included both risk and protective factors. However, due to a low rate of occurrence among the protective factors, these variables were dropped from the analyses and so are not reported on here.

[7]We have developed an R package of the *crimCV* software that is publically available on the Comprehensive R Archive Network (CRAN) at http://cran.r-project.org/.

[8]As our sample was criminal offenders, we conceptualized them as comparable to a clinical sample.

[9]This model is consistent with others reported in the literature, in terms of both the number and shape of the trajectories (e.g., Marshall 2006; Sampson, and Laub 2003; van der Geest et al. 2009). With regard to the number of trajectories, Bushway, Sweeten, and Nieubeerta (2009) and Jennings, Maldonado-Molina, and Komro (2010) also presented on seven-group models. Although both these studies had large samples (<3900), the length of the follow-up periods differed substantially at 60 years for the Bushway et al. study and 2 years with three waves of data for the Jennings et al. study. In terms of the shape of the trajectories, using a sample of

juvenile offenders in Australia, whose criminal activity was tracked from ages 10 to 20 years, Marshall's (2006) six-group model yielded similarly-shaped trajectories as the present study. For example, Marshall also found a high early group and a high late group (referred to as very high and high, respectively), a moderate early group and a moderate late group, and a low desister and a low persister group.

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Table 1

Trajectory Studies that Identify a High Rate Chronic Group and Risk Factors

Author(s)	Year	Sample	No. Groups	High Rate Group (offence variable)	Risk Factors
Fergusson, Horwood and Nagin	2000	community	4	chronic (3.1%) (variety[1])	early conduct problems; family adversity; social disadvantage
McDermott and Nagin	2001	community	3	Group 3 (4.6%) (frequency[2])	delinquent peers; negative labels of the child by parents
Chung, Hill, Hawkins, Gilchrist, and Nagin	2002	community	5	chronic (7.0%) (seriousness[3])	aggressive behaviour; poor family management; antisocial peers; poor academic achievement; community availability of drugs
Wiesner and Silbereisen	2003	community	4	high-level (14%) (frequency)	male gender; older age at Wave 1 of data collection; low parental monitoring and empathy; high peer tolerance of deviance
Wiesner, and Windle	2004	community	6	high-level chronic (6.4%) (frequency)	poor academic achievement; adjustment problems; unsupportive family; negative life events
Maldonado-Molina, Piquero, Jennings, Bird, and Canino	2009	community (Bronx)	5	Group 5 (1.3%) (variety)	sensation seeking; exposure to community violence
		community (San Juan)	4	none was found (variety)	

Davis, Banks, Fisher, and Grudzinskas	2004	high risk	3	high rate (12.1%) (frequency)	male gender; substance abuse/ dependence disorder
Piquero, Farrington, and Blumstein	2007	high risk	6	high rate chronic (2.5%) (frequency)	high level on composite environmental and individual risk factors
Hoeve, Blokland, Semon Dubas, Gerris, and van der Laan	2008	high risk	5	serious persisting (24.2%) (seriousness)	authoritarian parenting style
Wiesner, and Capaldi	2010	high risk	6	chronic high level (15.7%) (frequency)	attention problems; poor parental supervision; depressive symptoms; risky sexual behaviour; substance use; deviant peer group
Ryan, Hernandez, And Herz	2007	high risk	3	chronic (27.0%) (frequency)	poor school achievement
Marshall	2006	offender	6	very high (.9%) (frequency)	Indigenous status
Livingston, Stewart, Allard, and Ogilvie	2008	offender	3	chronic (11.0%) (frequency)	Indigenous status; male
Bersani, Nieuwbeerta, and Laub	2009	offender	4	chronic (4.0%) (frequency)	none was found
MacDonald, Haviland, and Morral	2009	offender	3 (violent)	high rate chronic (5.9%) (frequency)	delinquent peers
			3 (nonviolent)	high rate chronic (14.0%) (frequency)	delinquent peers; substance abuse

Monahan, Steinberg, Cauffman, and Mulvey	2009	offender	5	persister (5.7%) (variety)	deterioration of anger suppression and impulse control
van Domburgh, Vermeiren, Blokland, and Doreleijers	2009	offender	3	high rate (7.0%) (seriousness-frequency[4])	older at first offence; non-Western ethnicity
van der Geest, Blokland, and Biljeveld	2009	offender	5	high frequency chronic (5.9%) (frequency)	criminal family members; suicide attempts; delinquent peers
Yessine, and Bonta	2009	offender (Aboriginal)	2	chronic high (18.7) (seriousness-frequency)	delinquent peers; family dysfunction; substance use problems with accommodation
		offender (non-Aboriginal)	2	chronic high (12.3%) (seriousness-frequency)	
Ward, Day, Bevc, Sun, Rosenthal, and Duchesne	2010	offender	4	high rate adult-peaked (7.7%) (frequency)	alterative care involvement; criminal family members

Note: [1]Variety refers to the number of different antisocial/criminal behaviours committed at each time period. [2]Frequency refers to the total number of criminal behaviours/convictions at each time period. [3]Seriousness refers to the seriousness level of the most serious offence committed at each time period. [4]Seriousness-frequency uses a combination of frequency counts and seriousness ratings.

Table 2

LLIKE, BIC, AIC, and CVE Values for Number of Trajectory Groups

No. of Groups	LLIKE	BIC	AIC	CVE
1	-1676.783	23363.57	23400.83	0.7807739
2	-10197.414	20416.83	20498.80	0.6712001
3	-9735.615	19505.23	19631.92	0.6581372
4	-9561.060	19168.12	19339.52	0.6406352
5	-9406.668	18871.34	19087.45	0.6235395
6	-9321.148	18712.30	18973.13	0.6290606
7	-9242.408	18566.82	18872.36	**0.6159237**
8	-9195.662	**18485.32**	**18835.58**	0.6345287

Note: LLIKE is the log-likelihood of the fit; BIC is Bayesian Information Criterion; AIC is Akaike Information Criterion; CVE is cross-validation error. Boldface numbers indicate the optimal model.

Table 3

Mean (SD) Comparison Tests across Seven Trajectories Groups

Variable	Trajectory Groups						
	Moderate late persister (n = 14)	High late (n = 15)	High early (n = 17)	Moderate adolescence-peaked (n = 45)	Moderate early pesister (n = 55)	Low desister (n = 115)	Low persister (n = 125)
Age at first court contact	15.3_{ab} (2.3)	14.3_{a} (1.6)	15.0_{ac} (1.2)	14.4_{a} (1.6)	15.3_{ac} (1.5)	16.4_{b} (1.3)	15.8_{bc} (1.6)
Age at last court contact	31.9_{a} (3.9)	25.5_{bd} (3.7)	28.5_{a} (3.6)	24.6_{b} (3.4)	30.1_{a} (3.6)	19.5_{c} (1.8)	27.0_{d} (3.8)
Criminal trajectory length in years	16.6_{a} (4.2)	11.1_{b} (3.9)	13.5_{a} (3.7)	10.2_{b} (3.7)	14.7_{a} (3.9)	3.1_{c} (2.2)	11.1_{b} (3.7)
Total No.* court contacts (adjusted for time-at-risk)	52.1_{a} (16.0)	78.1_{b} (41.5)	62.7_{a} (19.0)	26.0_{c} (12.4)	27.3_{c} (7.2)	4.8_{d} (3.2)	9.7_{d} (4.1)

Note. *Number of court contacts was adjusted for time at risk. All oneway analyses of variance are significant, $p < .001$. All values in rows with different subscripts are significantly different from each other at the .05 level using the Scheffe post hoc test.

Table 4
Chi-square Analysis of Percentage of Predictors in Childhood across Seven Trajectory Groups

	Trajectory Groups							
Predictor	Moderate late persister (*n* = 13)	High late (*n* = 12)	High early (*n* = 15)	Moderate adolescence-peaked (*n* = 39)	Moderate early persister (*n* = 51)	Low desister (*n* = 105)	Low persister (*n* = 114)	$\chi^2(6)$
Individual domain								
Hyperactivity-impulsivity-inattention	23.1	16.7	13.3	17.9	15.7	8.6	16.7	4.71
Antisocial behaviour	46.2	58.3	40.0	53.8	29.4	32.4	31.6	11.22
Alcohol and/or drug use	0.0	0.0	0.0	5.1	3.9	4.8	3.5	2.10
Health problems	15.4	8.3	13.3	12.8	5.9	11.4	14.9	3.09
Low self-esteem	0.0	0.0	6.7	2.6	2.0	2.9	5.3	3.04
Extrafamilial sexual abuse	7.7	8.3	0.0	7.7	7.8	2.9	1.8	6.86
Immigrant/refugee	16.7	9.1	8.3	15.4	20.4	18.4	9.3	5.70
Death of a caregiver/significant other	7.7	16.7	13.3	5.1	5.9	6.7	7.0	2.91
Family domain								
Criminal family members	0.0	8.3	0.0	10.3	11.8	6.7	7.9	4.03
Parental psychopathology	15.4	16.7	33.3	23.1	17.6	16.2	24.6	4.57
Poor child-rearing methods	30.8	41.7	53.3	46.2	27.5	27.6	33.3	8.35
Family abuse	23.1	33.3	46.7	33.3	17.6	15.2	17.5	14.09**
Family relationship problems	15.4	25.0	33.3	25.6	35.5	19.0	21,1	2.77
Broken home/family transitions	61.5	66.7	53.3	69.2	47.1	43.8	50.9	9.46
Involvement with alternative care	38.5	33.3	33.3	30.8	27.5	20.0	21.1	5.48
Adolescent mother	0.0	0.0	0.0	7.7	2.0	2.9	4.4	4.30
Peer domain								

Poor relations with peers	0.0	8.3	6.7	5.1	0.0	8.6	14.9	12.47
School domain								
Poor academic achievement	53.8	16.7	26.7	17.9	17.6	26.7	28.1	9.30
Poor school behaviour	0.0	16.7	6.7	15.4	7.8	12.4	6.1	6.49

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 5
Chi-square Analysis of Percentage of Correlates in Adolescence across Seven Trajectory Groups

	Trajectory Groups							
Correlate	Moderate late persister (n = 13)	High late (n = 12)	High early (n = 15)	Moderate adolescence-peaked (n = 39)	Moderate early persister (n = 51)	Low desister (n = 105)	Low persister (n = 114)	$\chi^2(6)$
Individual domain								
Hyperactivity-impulsivity-inattention	46.2	50.0	86.7	43.6	37.3	41.0	25.1	15.49*
Antisocial behavior	92.3	83.3	100	94.9	96.1	85.7	87.7	8.00
Alcohol and/or drug use	84.6	41.7	73.3	64.1	74.5	66.7	65.8	7.13
Callousness	38.5	25.0	53.3	43.6	47.1	42.9	38.6	3.43
Lack of responsibility for behaviour	38.5	33.3	60.0	35.9	39.2	41.0	41.2	3.05
Health problems	0.0	8.3	26.7	7.7	25.5	12.4	14.0	11.30
Low self-esteem	23.1	16.7	13.3	35.9	21.6	26.7	23.7	4.62
Extrafamilial sexual abuse	0.0	0.0	6.7	2.6	0.0	2.9	0.9	4.95
Immigrant/refugee	7.7	8.3	0.0	5.1	2.0	1.0	1.8	6.41
Death of a caregiver/significant other	0.0	8.3	20.0	2.6	3.9	8.6	10.5	7.80
Homelessness	30.8	8.3	26.7	17.9	11.8	13.3	13.2	5.86
Suicidality	15.4	25.0	26.7	25.6	17.6	22.9	14.9	4.13
Family domain								
Criminal family members	7.7	16.7	20.0	12.8	13.7	14.3	12.3	1.24
Parental psychopathology	7.7	0.0	20.0	20.5	11.8	13.3	13.2	4.59
Poor child-rearing methods	38.5	33.3	46.7	35.9	33.3	31.4	29.8	2.23
Family abuse	7.7	8.3	40.0	12.8	11.8	4.8	7.9	20.27**
Family relationship problems	30.8	66.7	46.7	71.8	51.0	38.1	48.2	16.39**
Broken home/family transitions	46.2	41.7	66.7	46.2	45.1	37.1	50.9	7.08

Involvement with alternative care	30.8	41.7	46.7	38.5	23.5	18.1	14.0	19.73**
Peer domain								
Poor relations with peers	69.2	66.7	73.3	82.1	76.5	67.6	72.8	3.73
School domain								
Poor academic achievement	53.8	25.0	60.0	23.1	25.5	41.0	40.4	13.08*
Poor school behavior	76.9	58.3	73.3	64.1	52.9	64.8	60.5	4.41

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 6

Multinomial Logistic Regression of Trajectory Group Membership as a Function of Childhood Predictors (Low Desister Group was the Base Reference Group)

Comparison	Predictor	B	*SE*	Odds Ratio	Wald
Moderate late persister vs. Low desister	Poor academic achievement	1.12	.67	3.08	2.85
	Antisocial behavior	.10	.66	1.11	.02
	Intercept	-2.57	.45		32.83***
High late vs. Low desister	Poor academic achievement	-1.20	.85	.30	2.01
	Antisocial behavior	1.43	.65	4.17	4.77*
	Intercept	-2.55	.47		29.97***
High early vs. Low desister	Poor academic achievement	-.17	.68	.84	.07
	Antisocial behavior	.40	.62	1.47	.41
	Intercept	-2.04	.36		31.51***
Moderate adolescence-peaked vs. Low desister	Poor academic achievement	-1.03	.51	.36	4.09*
	Antisocial behavior	1.21	.41	3.35	8.59**
	Intercept	-1.28	.27		22.81***
Moderate early persister vs. Low desister	Poor academic achievement	-.55	.46	.58	1.42
	Antisocial behavior	.05	.40	1.05	.02
	Intercept	-.62	.21		8.61**
Low persister vs. Low desister	Poor academic achievement	.10	.33	1.11	.21
	Antisocial behavior	-.08	.32	.93	.06
	Intercept	.08	.17		.21

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 7

Multinomial Logistic Regression of Trajectory Group Membership as a Function of Adolescent Correlates (Low Desister Group was the Base Reference Group)

Comparison	Correlate	B	*SE*	Odds Ratio	Wald
Moderate late pesister vs. Low desister	Poor academic achievement	.50	.64	1.64	.60
	Family relationship problems	-.49	.66	.61	.57
	Involvement with alternative care	.57	.69	1.76	.68
	Intercept	-2.29	.46		24.98***
High late vs. Low desister	Poor academic achievement	-1.49	.75	.23	3.94*
	Family relationship problems	1.38	.67	3.99	4.32*
	Involvement with alternative care	1.49	.68	4.43	4.79*
	Intercept	-2.83	.56		25.30***
High early vs. Low desister	Poor academic achievement	.38	.62	1.46	.38
	Family relationship problems	.16	.58	1.18	.08
	Involvement with alternative care	1.23	.61	3.43	4.11*
	Intercept	-2.59	.49		28.13***
Moderate adolescence-peaked vs. Low desister	Poor academic achievement	-1.61	.48	.20	11.24***
	Family relationship problems	1.66	.43	5.23	14.86***
	Involvement with alternative care	1.36	.46	3.89	8.73**
	Intercept	-1.76	.35		24.79***
Moderate early persister vs. Low desister	Poor academic achievement	-1.05	.41	.35	6.50*
	Family relationship problems	.73	.36	2.08	4.11*
	Involvement with alternative care	.60	.44	1.81	1.81
	Intercept	-.83	.26		10.36***
Low persister vs. Low desister	Poor academic achievement	-.10	.30	.92	.10
	Family relationship problems	.46	.29	1.58	2.54
	Involvement with alternative care	-.32	.38	.73	.68
	Intercept	-.03	.20		.02

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p \leq .001$.

Figure 1

Estimated Criminal Trajectories for Seven-Group Model