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Male and female offending trajectories

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Abstract
This paper uses a latent class modeling approach to examine gender related variations in offending trajectories from adolescence to young adulthood. This approach is applied to data gathered over the course of a longitudinal study of 896 New Zealand children studied from birth to age 21 years. The analysis identified five trajectory groups: a group of low-risk offenders, three groups of adolescent-limited offenders who varied in the timing of the onset of offending (early, intermediate, and late onset), and a group of chronic offenders. Identical offending trajectories applied for males and females. However, probabilities of trajectory group membership varied with gender, with females being more likely to exhibit low-risk or early onset adolescent-limited offending and males later onset and chronic offending. Examination of social, family, and individual factors associated with these trajectories suggested the presence of a series of common etiological factors relating to family functioning and early adjustment that discriminated between trajectory groups. These risk factors appeared to operate in a similar fashion for both males and females. Implications of these findings for trajectory theories of offending are discussed.

In recent years, there has been interest in and research into what may be described as trajectory theories of the development of antisocial behavior and crime. A key assumption of these theories has been that the risk factors and life processes associated with early onset chronic delinquent behavior differ from the risk factors and life processes associated with later onset adolescent-limited offending (Catalano & Hawkins, 1996; Fergusson, Horwood, & Nagin, 2000; Fergusson, Lynskey, & Horwood, 1996; Loeber & LeBlanc, 1990; Moffitt, 1993; Nagin, Farrington, & Moffitt, 1995; Patterson, 1996; Patterson & Yoerger, 1997; Sampson & Laub, 1993; Silverthorn & Frick, 1999).

Theories advanced by Moffitt (Moffitt, 1993; Moffitt, Caspi, Dickson, Silva, & Stanton, 1996) and by Patterson and his colleagues (Patterson, 1996; Patterson, DeBaryshe, & Ramsey, 1989; Patterson, Forgatch, Yoerger, & Stoolmiller, 1998; Patterson & Yoerger, 1997) are two prominent examples of such theories. Moffitt (1993) proposed that the shape of the age–crime curve could be best explained by assuming the presence of two general subpopulations of young offenders. One of these subpopulations comprise life-course-persistent offenders who show an early onset of offending and a continued propensity to offend over their life course. Moffitt proposes that this group is drawn from a larger population of individuals who very early in life have deficits in neuropsychological functioning such as impaired cognitive ability and difficult temperament. For a small proportion of this group these deficits mediate the child's interactions with the social and family environment in such a way as to reinforce and exacerbate antisocial behaviors. The second subpopulation comprises adolescent-limited offenders who engage in delinquent behaviors only in adolescence. In contrast to the etiology of life-course-persistent offend-

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ing, the etiology of adolescent-limited offending arises as a result of processes of social mimicry that lead this group to mimic the behaviors of their delinquent peers.

In a series of articles, Patterson and his associates (Patterson, 1996; Patterson et al., 1989, 1998; Patterson & Yoerger, 1997) have developed an account of the etiology of early onset and later onset delinquency that has many points of similarity with Moffitt's account. Like Moffitt, they assume that individuals who show an early onset of antisocial behavior have a greater predisposition to long-term offending than those who show a late onset. They suggest that early onset delinquency is largely shaped by a series of family processes, including inept parental discipline, poor parental monitoring, and impaired family problem solving, that creates a socialization process in which children learn that coercive and antisocial behaviors have an adaptive value. In contrast, those who show late (after 14 years) onset offending lack the marked family difficulties that are present for the early onset group but are nonetheless exposed to greater family difficulties than nonoffenders. The moderate risk status of this group is exacerbated by the formation of affiliations with delinquent peers who may act to encourage, reward, and sustain tendencies to antisocial behaviors.

Although there has been increasing research evidence (Lynam, 1996; Moffitt et al., 1996; Patterson, 1996; Patterson et al., 1989, 1998; Patterson, Reid, & Dishion, 1992; Patterson & Yoerger, 1997) to support the distinction between early onset life-course-persistent offending and later onset adolescent-limited offending, there are a number of important issues relating to this distinction that require exploration. In particular, in a recent review of the development of offending, Silverthorn and Frick (1999) note that accounts that distinguish between life-course-persistent and adolescent-limited offending have been derived either from male samples or from general population samples that were not stratified by gender. They propose that while the distinction between adolescent-limited and life-course-persistent offending may describe the development of offending in males, this account does not accurately describe the development of offending in females. In particular, they suggest that females do not exhibit the early onset pattern characteristic of some male offending. Rather, they suggest that female offending follows a single common trajectory in which the onset of offending is delayed until adolescence. They describe this trajectory as the delayed onset trajectory and comment that "data supports the presence of only one developmental trajectory for antisocial girls, a trajectory that has many commonalities with the childhood onset for boys but for girls typically has an adolescent onset" (p. 114). More generally, Silverthorn and Frick's comments can be seen as part of a wider interest in the issue of the extent to which the development of antisocial behaviors in males and females follows similar developmental pathways and involves similar risk factors (Fergusson, Woodward, & Horwood, 2000; Giordano & Cernkovich, 1997; Keenan & Shaw, 1997; Zoccolillo, 1993).

In this article, we use data gathered over the course of a 21-year longitudinal study of a birth cohort of New Zealand born children to examine gender differences in both offending trajectories and gender differences in the risk factors for offending behaviors. The overarching focus of this investigation was to examine the extent to which the development of criminal offending in males and females could be described by a common theoretical model applicable to both gender groups and the extent to which there was evidence of gender specific differences in the development of crime or the risk factors associated with crime. The technical background to the trajectory analysis used in this study is developed below.

Fitting Trajectory Models and Testing Gender Differences

Although trajectory theories of crime have become increasingly popular as accounts of differences in the development of crime, until recently methods for testing these theories have not been available and the classification of offenders into early onset life-course-persistent or late onset adolescent-limited offend-

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ers relied upon subjective classification of individuals into offender types (Moffitt et al., 1996; Patterson & Yoerger, 1997). In turn, this reliance on subjective classification rules limited the extent to which trajectory theories could be subject to empirical test. Further, while subjective assignment rules may appear reasonable there are limitations and pitfalls attendant to their use. In particular, these methods may be susceptible to both "overfitting" and "underfitting" data—creation of trajectory groups that reflect only random variation while at the same time failing to identify groups with actually distinct trajectories.

However, recently there have been attempts made to devise statistical methods for classifying subjects into groups based on their developmental trajectories. Specifically, Nagin and Land (1993) proposed a Poisson distribution based latent class model in which each latent class is characterized by a specific offending trajectory that is described by a polynomial function of age. This model has been described more recently by Nagin (1999) as the semiparametric group based (SPGB) method for analyzing developmental trajectories. The SPGB methodology has the advantage of making it possible to expose taxonomic theories of group differences to more rigorous empirical testing.

In a recent article, Fergusson, Horwood, and Nagin (2000) have drawn attention to the fact that in a situation in which offending is measured by a dichotomous (offender–nonoffender) classification the SPGB model can be represented by an entirely nonparametric latent class model. This model is described below.

Consider a sample of subjects studied on a series of occasions. Assume that on each occasion subjects are classified as offenders or nonoffenders and that this classification is represented by a dichotomous response variable X_t that is scored $X_t = 1$ if the subject is an offender at time t and $X_t = 2$ if not an offender.[1] The offending history of the sample is, thus, represented by 2^T response patterns that range from the response pattern $(1, 1 \cdots 1)$ in which the subject is observed to offend on all (T) occasions to the response pattern $(2, 2 \cdots 2)$ in which the subject is observed to offend on no occasion.

In theory, each observed response pattern could be treated as though it represented a unique offending trajectory. However, there are two objections to this practice. First, even with a moderate number of time periods the number of distinct offending trajectories will become unmanageably large and the observed data will be sparse for some trajectories. Second, and more fundamentally, some of the apparent variation in response patterns may reflect measurement errors and other sources of response variability rather than genuine trajectories of criminal behavior. For both reasons, it is desirable to consider ways of reducing the 2^T response patterns down to a smaller number of groups following common and recurrent response trajectories.

One solution to this problem is provided by the latent class modeling framework (Clogg, 1995; Clogg & Goodman, 1984, 1985). Our model assumes that the variability in the observed response data represents the presence of a number of latent groups $G_1, G_2 \cdots G_J$ with each group j having a characteristic offending trajectory. The model is defined by a series of equations linking the observed responses, X_t, to the latent groups, G_j, and by an identifying condition (conditional independence) that permits estimation of the parameters of these equations. Specifically, the model assumes that the offending trajectory of each group is described by a series of T parameters a_{tj} where a_{tj} denotes the probability that a member of group j will be observed to offend at time t. The offending trajectories for the J groups are thus described by a set of $T \times J$ parameters a_{tj} that define the within class offending trajectories. The model also

1. It could be suggested that the use of dichotomous variables to describe offending is imprecise since these measures do not take into account the severity or frequency of offending. However, trajectory theories are about patterns of offending onset and offset. The advantage of dichotomous variables is that these measures describe offending onset and offset in a way that is not confounded by other aspects of offending. This opens the way to examining the linkages between offending trajectory (i.e., the onset and offset of offending) and measures of offense severity and frequency.

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requires the estimation of J – 1 parameters p_j that estimate the probability of membership of the J trajectory groups. The identifying condition that permits estimation of the parameters a_{tj}, p_j is that the observed responses X_t are statistically independent for subjects who are members of the same latent class. More generally, conditional independence implies that

$$\Pr(X_1 = r_1;\ X_2 = r_2 \cdots X_T = r_T | G_j) = \prod_{t=1}^{T} \Pr(X_t = r_t | G_j) \quad (r_t = 1 \text{ or } 2).$$

The appeal of the approach is that it provides a strategy for reducing large numbers of varying response patterns in the offending history data to a smaller number of latent groups, with each group having an offending trajectory defined by the set of a_{tj} values for that group. The approach is nonparametric, because no functional relationship is assumed between age and risk of offending.

Model identification depends both on the number of time periods and the number of latent groups. For example, it is possible to fit a two-group model to data for three time periods, but with seven time periods (as in the present analysis) it is potentially possible to estimate parameters for more than 10 trajectory groups.

One important advantage of the latent class modeling approach described above is that it leads straightforwardly to tests of gender differences in offending trajectories. In particular, within the latent class model framework, it is possible to devise multiple group models that permit testing of the equality of the model parameters a_{tj} and p_j across gender groups (Clogg, 1995; Clogg & Goodman, 1985).[2] Tests of the equality of the parameters a_{tj} amount to examining the extent to which the same trajectory "shapes" describe variations in male and female offending, whereas tests of the equality of the parameters p_j amount to tests of the between gender similarity in the probability of membership of the trajectory groups $G_1 \cdots G_j$.

In addition, it is possible to assign subjects to trajectory groups by computing the posterior probability that a subject showing a given response pattern is a member of a given latent group. In turn, this approach makes it possible to explore the ways in which various social, individual, family, and related factors are related to membership of a given trajectory group.

Model fitting is conducted using maximum likelihood estimation. This leads to a standard log likelihood ratio chi-square test of model fit (Clogg, 1995). However, the log likelihood ratio test may be suspect when applied to sparse data; further, it is not an appropriate test for comparing the fit of non-nested models and alternative indices of fit need to be considered (van de Pol, Langeheine, & de Jong, 1999). One commonly used alternative is the Akaike Information Criterion (AIC; Akaike, 1974). This index rewards parsimony in model specification by imposing a penalty function on the log likelihood for increasing the number of model parameters to be estimated. Using this measure, the best fitting model from a series of alternatives is the model with the smallest information criterion value. In this application, model fitting was conducted using the program PANMARK (van de Pol et al., 1999).

Aims of the Present Study

In this article, we report on data gathered on juvenile offending over the period from age 12 to age 21 years in a New Zealand birth cohort studied to the age of 21 years. The aims of this study were as follows: (a) to apply the latent class trajectory model described above to examine the extent to which distinct early onset and adolescent limited trajectories can be identified; (b) to examine the extent to which models of offending trajectory vary with gender; (c) to examine the

2. It has been suggested to us that, rather than fitting a multiple group model, it may be preferable to stratify the sample by gender and fit separate models for males and females. There are potentially two limitations of this approach. First and foremost, fitting separate models fails to provide tests of the equality of model parameters for males and females. In contrast, these tests can be obtained routinely using a multiple group modelling approach. Second, the approach will result in a loss of precision for the estimate of any parameter that is equal for males and females.

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ways in which memberships of trajectory groups vary with antecedent social, family, and child factors; and (d) to examine whether the risk factors associated with female offending trajectories differ from the risk factors associated with male offending trajectories.

More generally, the aim of this study is to use data gathered over the course of a 21-year longitudinal study of a population sample to examine the extent to which males and females follow similar trajectories in the development of crime and the extent to which risk factors for crime vary with gender.

Method

The data described in this article were gathered during the course of the Christchurch Health and Development Study (CHDS). The CHDS is a longitudinal study of an unselected birth cohort of 1,265 children (635 boys, 630 girls) born in the Christchurch, New Zealand, urban region during mid-1977. These children have now been studied at birth, 4 months, annually from age 1 year to age 16 years, and again at ages 18 and 21 years, using information gathered from a combination of sources, including parental or significant other report, teacher report, self-report, standardized psychometric testing, and medical and other official records. For an overview of the study design and methodology, see Fergusson, Horwood, Shannon, and Lawton (1989). The following measures were used in the analysis.

Measures of juvenile offending

Each year from age 12 to age 16 years, sample members and their parents were questioned about the young person's juvenile offending behaviors over the preceding year using the Self-Report Early Delinquency Scale (SRED; Moffitt & Silva, 1988). At 18 and 21 years, sample members and a "significant other" respondent nominated by the subject were also questioned about the young person's offending behaviors over the preceding year with a modified version of the Self-Report Delinquency Instrument (SRDI; Elliott & Huizinga, 1989). For the purposes of the present analysis, sample members were classified as having offended in a given year if they were reported on the basis of either self-report or parent or significant other report to have committed either a property or violent offense. Property offenses included vandalism, breaking and entering, vehicle theft, shoplifting, and other theft; violent offenses included assault, fighting, using a weapon, physical coercion, and cruelty to animals. Most of the analysis is based on a combined measure of property or violent offending. However, the two types of offending are considered separately in the Supplementary Analyses section.

To supplement the measures of offending gathered from age 12 years onwards and to provide a measure of the child's behavioral tendencies prior to age 12 years, the trajectory analysis was extended to include a measure of early conduct problems. This measure was based on parallel parental and teacher reports of the child's tendencies to disruptive or conduct-disordered behaviors gathered at ages 8, 9, and 10 years using an instrument that combined items from the Rutter, Tizard, & Whitmore (1970) and Conners (1969, 1970) parent and teacher child behavior questionnaires (Fergusson, Horwood, & Lloyd, 1991). To provide an overall measure of the child's behavioral tendencies over the period from 8 to 10 years, assessments based on parent and teacher reports at each year were standardized to a mean of 0 and a standard deviation of 1. These assessments were then summed over the 3-year period to produce a composite measure that ranked children according to parent and teacher reports of conduct problems. The resulting score had high internal consistency ($\alpha = .97$).

For analysis purposes, children were classified as exhibiting behavior problems if their scores placed them in the most disturbed 10% of the cohort.

Social, family, and individual factors associated with juvenile offending

To examine the childhood, family, and related factors associated with different trajectories of offending, a diverse set of measures were selected from the database of the CHDS. As far

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as possible, the measures were chosen to reflect the child's social, family, and related characteristics assessed prior to the age of 12 years.

Measures of sociodemographic background.

Maternal age. This was assessed at the time of the survey child's birth.

Maternal education level. This was assessed at the time of the survey child's birth and coded on a 3-point scale reflecting the mother's highest level of educational attainment: no formal educational qualifications, secondary level qualifications, or tertiary level qualifications.

Family socioeconomic status. This was assessed at the time of the survey child's birth using the Elley and Irving (1976) scale of socioeconomic status for New Zealand. This scale classifies families into six levels on the basis of paternal occupation, ranging from professional and managerial to unskilled and unemployed.

Family living standards (*0–10 years*). At each assessment from age 1 to age 10 years the living standards of the family were rated by survey interviewers on a 5-point scale that ranged from *very good* to *very poor*. These ratings were averaged over the 10-year period to provide a measure of typical family living standards during this period.

Measures of family functioning and parental adjustment.

Changes of parents (*0–10 years*). As part of the research, information was obtained at annual intervals on changes of parents experienced by the child. To provide an overall index of family stability, a count of the total number of changes of parents experienced by the child up to age 10 years was constructed. Changes of parents were taken to include all changes resulting from parental separation or divorce, remarriage, reconciliation, parental death, placement with foster parents, and any other change of custodial parents (Fergusson, Horwood, & Lynskey, 1992).

Parental conflict (*0–10 years*). Parents were questioned annually on two items that described the quality of marital relationships. These items were (a) whether the parents had engaged in prolonged arguments during the last 12 months and (b) whether the child's mother reported being assaulted by her spouse in the last 12 months. These items were summed over the 10-year period to produce a measure of the duration of conflictful or assaultive relationships between parents.

Parental criminality. When sample members were age 15 years, their parents were questioned as to whether any parent had a history of criminal offending. On the basis of this classification, 12.2% of the sample were classified as having a parental history of criminality.

Parental history of alcoholism or alcohol problems. When sample members were age 15 years, their parents were questioned as to whether any parent had a history of alcoholism or alcohol problems. On this basis, 11.6% of the sample were classified as having such problems.

Parental illicit drug use. When sample members were aged 11 years, their parents were questioned on the extent to which they had used cannabis or other illicit drugs. On this basis, 24.4% of the sample were classified as having such a parental history.

Child intelligence. At age 8 years, sample members were assessed using the revised Wechsler Intelligence Scale for Children (WISC-R; Wechsler, 1974). For the purposes of the present analysis, the full-scale IQ score was used. The reliability of this measure, assessed using split half methods, was. 93.

Self-esteem. This was assessed at age 10 years using the Coopersmith Self-Esteem Inventory (SEI; Coopersmith, 1981). The full scale score was used in the present analysis. The reliability of this scale, assessed using coefficient alpha, was .89.

Novelty seeking. When sample members were aged 16 years they were administered the novelty-seeking items of the Tridimensional Personality Questionnaire (Cloninger, 1987). Novelty seeking assesses the extent to which the individual is "impulsive, exploratory, excitable, disorderly and distractible" (Cloninger, 1987, p. 411). These items were summed to produce an overall novelty-seeking measure. The reliability of this scale, assessed using coefficient alpha, was .76.

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Sample size

The analyses reported in this article are based on the sample of 896 subjects for whom there was complete data on conduct problems at age 8–10 years and offending reports over the period from age 12 to 21 years. This sample represented 71% of the original cohort of 1,265 children. To examine the effects of sample losses on the representativeness of the sample, comparisons were made between the obtained sample and the remaining 369 sample members excluded from the analysis on a range of sociodemographic measures collected at birth. This analysis suggested that losses to follow up were unrelated to the child's gender, ethnicity, family size, or maternal age. However, there were small but statistically detectable ($p < .01$) tendencies for the obtained sample to underrepresent children from families in which mothers lacked formal educational qualifications, families of lower socioeconomic status, and single-parent families.

While these results show some bias in the sample towards underrepresentation of children from socially disadvantaged backgrounds, it is unlikely that this bias will materially influence the results reported here. Previous studies, in which statistical corrections for nonrandom sample loss have been applied, suggest that the impact of nonrandom sample attrition on study results is negligible (Fergusson, Horwood, & Lynskey, 1997; Fergusson & Lloyd, 1991).

Results

Age–offending curve for males and females

Figure 1 shows a plot of the age–offending curves for males and females. This figure shows, for each assessment from age 12 to age 21 years, the proportion of cohort members who reported property or violent offending in the preceding year. Since assessments gave accounts of offending in the preceding year, the figure reports on offense rates over the period from 11 to 20 years. Three facts are clearly evident from this figure:

1. There was a clear trend, for both males and females, for rates of offending to increase until age 17 and decline thereafter.
2. At all ages the female offending rate was lower than the male rate.
3. The age–offending curves for males and females are virtually parallel, suggesting that males and females followed similar overall offending pathways, although females offended at a lower rate. Typically, the female rate of offending was approximately half the male rate of offending in any year.

However, a clear limitation of the plot in Figure 1 is that it presents aggregate data and does not examine data for trajectory groups. The fact that males and females have similar shaped overall age–offending distributions does not imply that the underlying offending trajectory groups for males and females are necessarily the same.

Offending trajectories for males and females

To examine the extent to which males and females followed similar offending trajectories, the latent trajectory model described earlier was fitted to data on reports of offending at ages 11–15, 17, and 20 years. In addition, the fitted model included a measure of whether the young person displayed conduct problems during the interval from 8 to 10 years. This measure was included in the model to provide a measure of early onset problem behavior in addition to the measures of offending gathered over the period from 11 to 20 years. For these data, there were a possible 256 response patterns describing the early behavior and subsequent offending history of the cohort. The aims of the latent class analysis were to reduce these patterns to a smaller number of latent classes representing common trajectories. The process by which models were fitted is described below.

In the first stage of the trajectory modeling process, trajectory models were fitted to the overall data for the total cohort: two through six class models were fitted. Table 1 shows measures of the goodness of fit of these models based on two goodness of fit indices: (a)

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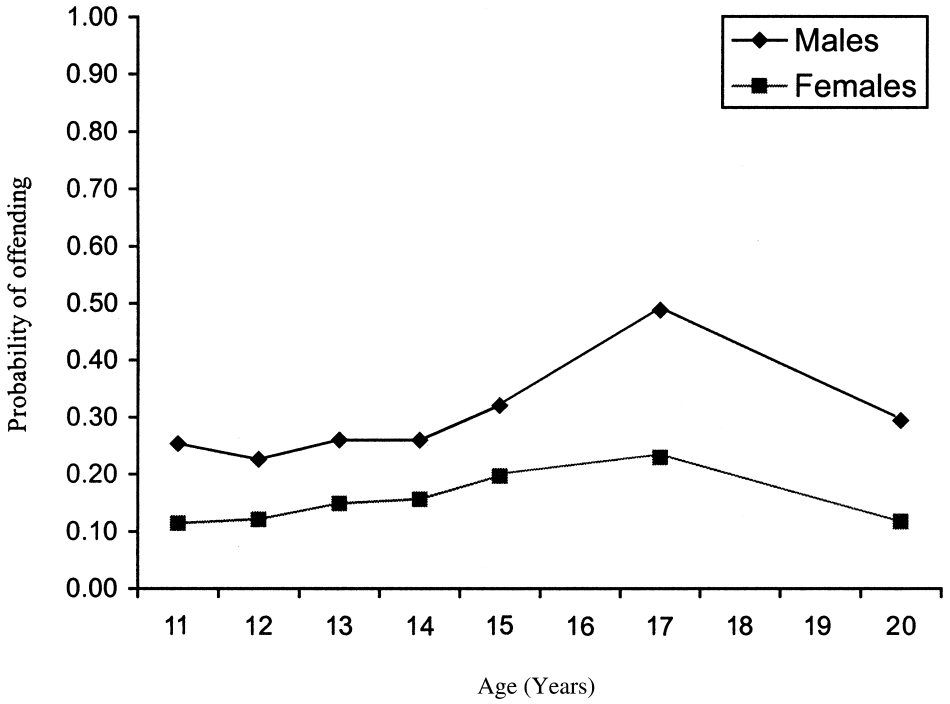


Figure 1. Annual probabilities of violent or property offending for males and females (11–20 years).

Table 1. *Goodness of fit indices for models with varying numbers of latent classes*

No. Latent Classes	Log Likelihood χ^2 (*df*)	*p*	AIC
2	369.4 (238)	<.0001	6191
3	267.4 (229)	<.05	6107
4	219.7 (220)	>.40	6078
5	187.4 (211)	>.85	6063
6	181.0 (202)	>.80	6075

the log likelihood ratio chi-square goodness of fit statistic; (b) the AIC. On the basis of these indices, a five-class model was chosen as providing the best account of the data. In particular, the log likelihood ratio chi-square tests showed that two- and three-class models failed to fit the data, whereas the AIC suggested that a five-class model provided a more parsimonious account of the data than either a four- or six-class model. To address gender differences, the data were subdivided by gender and multiple group models were then fitted to the data. This analysis showed that a five-group model also gave the best account of the data when the sample was subdivided by gender.

In the final stage of the analysis a series of alternative five-group models was fitted to the data for males and females to test the plausibility of possible alternative constraints on the model parameters. These models were as follows:

1. Model 1. All model parameters were permitted to vary with gender.
2. Model 2. The offending rate parameters a_{tj} were set equal across gender groups, but the group membership probabilities p_j were permitted to vary with gender.
3. Model 3. The group membership probabilities p_j were set equal across gender groups, but the offending rate parameters a_{tj} were permitted to vary with gender.
4. Model 4. All parameters were set equal across gender groups.

Table 2 reports on the goodness of fit sta-

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Table 2. *Comparison of goodness of fit indices for alternative five-class models stratified by gender*

Model	Log Likelihood χ^2 (*df*)	*p*	AIC
Model 1: Unconstrained model	303.9 (422)	>.90	7249
Model 2: Offending rates (a_{ij}) set equal for males and females, group membership probabilities (p_j) unconstrained	346.8 (462)	>.90	7211
Model 3: Group membership probabilities (p_j) set equal for males and females, offending rates (a_{ij}) unconstrained	332.3 (426)	>.90	7269
Model 4: All parameters set equal for males and females	449.7 (466)	>.60	7307

tistics for these models. It is apparent that, although all models fitted the data on the basis of the log likelihood ratio chi-square statistic, the AIC suggests that Model 2 provided the best overall fit. Further, since Models 2 and 3 are nested within Model 1, the differences in chi square and degrees of freedom between these models can be used to provide tests of the plausibility of the model constraints (Clogg, 1995). Specifically, the chi-square difference between Models 1 and 2 is nonsignificant, $LR\ \chi^2\ (40) = 42.9$, $p > .50$, suggesting that the offending rate parameters for males and females can be constrained equal. However, the difference between Models 1 and 3 is highly significant, $LR\ \chi^2\ (4) = 28.4$, $p < .001$, suggesting that the group membership probabilities cannot be constrained equal for males and females. Thus the best fitting and most parsimonious model (Model 2) was one in which (a) the offending rate parameters were set equal across groups and (b) the probability of group membership was permitted to vary with gender. This model implies that males and females were described by a common set of offending trajectories but that the probability of membership of a given offending trajectory group varied with gender.

Table 3 reports on the fitted model parameters for males and females. The table shows that the sample was described by five offending trajectory groups. These groups were as follows:

1. Group 1 (low-risk offenders): This trajectory was followed by 41% of males and 71% of females. Young people following this trajectory had very low rates (less than 2%) of conduct problems during middle childhood (8–10 years) and generally low rates of offending during adolescence, with a small increase in offending risk at age 17 years and a decline thereafter. This group is very clearly a group of nonantisocial young people who very occasionally lapsed into offending.
2. Group 2 (early onset adolescent-limited offenders): This trajectory was followed by 14.7% of males and 21.0% of females. This group had relatively low rates (8%) of conduct problems during middle childhood. Their offending probabilities show a group characterized by a moderate risk of offending in early adolescence, rising to a peak risk of 50% at around the age of 13 years and declining to a lower risk (approximately 20%) from age 17 years onward. This is clearly a group who showed an onset of offending during early adolescence, with this behavior subsiding at around the age of school leaving.
3. Group 3 (intermediate onset adolescent-limited offenders): This trajectory was followed by 10.3% of males and 3.7% of females. Like Group 2, most of this group (87%) did not have early conduct problems.

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Table 3. *Fitted parameters (and standard errors) for five-class model with offending probabilities constrained equal for males and females*

Class	Probability of Reporting Offending at a Given Age (Years)								Probability of Group Membership	
	8–10[a]	11	12	13	14	15	17	20	Males	Females
Group 1: Low-risk offenders	.019	.034	.014	.000	.024	.058	.158	.063	.407	.708
	(.007)	(.011)	(.011)	(—)[b]	(.012)	(.014)	(.021)	(.015)	(.034)	(.036)
Group 2: Early onset adolescent-limited offenders	.083	.241	.338	.501	.351	.294	.173	.212	.147	.210
	(.030)	(.048)	(.056)	(.086)	(.063)	(.056)	(.081)	(.048)	(.047)	(.045)
Group 3: Intermediate onset adolescent-limited offenders	.130	.108	.000	.542	.887	.844	.907	.363	.103	.037
	(.052)	(.066)	(—)[b]	(.093)	(.131)	(.103)	(.087)	(.075)	(.033)	(.015)
Group 4: Late onset adolescent-limited offenders	.123	.336	.287	.207	.103	.342	.845	.539	.249	.024
	(.040)	(.066)	(.064)	(.060)	(.089)	(.071)	(.103)	(.077)	(.058)	(.025)
Group 5: Chronic offenders	.584	.864	1.000	.775	.834	.901	.782	.500	.094	.021
	(.082)	(.058)	(—)[b]	(.068)	(.071)	(.060)	(.067)	(.077)	(.017)	(.008)

[a]At 8–10 years the measure is based on the number of conduct problems reported over this period (see Methods section).
[b]Parameter converged to zero or one during estimation, standard error cannot be estimated.

The shape of their offending trajectory is similar to that for Group 2 except that the onset of offending occurs later, at around the age of 13 years, with the peak risk (91%) in offending occurring at 17 years and declining thereafter. This group is very clearly a group of adolescent-limited offenders whose offending behaviors peak over the period from 14 to 17 years and decline thereafter.

4. Group 4 (late onset adolescent-limited offenders): This trajectory was followed by 24.9% of males and 2.4% of females. As for Groups 2 and 3, this group was characterized by a relatively low rate (12%) of conduct problems in middle childhood. Members of this group had a low to moderate risk of offending prior to age 17 years, with this risk increasing rapidly at 17 years to nearly 85% and declining at age 20 years. This group is very clearly a group of predominantly male teenagers who show an abrupt increase in offending at around the age of 17 years with this increase declining by the age of 20 years.

5. Group 5 (chronic offenders): This trajectory was followed by 9.4% of males and 2.1% of females. The majority (58%) of this group had early conduct problems, and their rates of offending were generally very high from age 11 to 17 years but showed some decline at age 20 years. The trajectory shape suggests a group of early onset and chronic offenders who showed some tendency to desistance with increasing maturity.

Trajectory groups and rates of offending

The trajectory groups shown in Table 3 describe patterns of offending onset and offset among the cohort. However, the analysis does not take into account variations in the frequency of offending for individuals following different offending trajectories. This issue was addressed in the following way.

First, subjects were assigned to trajectory groups using Bayes' theorem and the model parameters shown in Table 3. Nagin (1999) has described how the parameters of the latent class model can be used to make such group assignments. It was estimated that subjects were assigned to groups with 90% accuracy.[3]

Table 4 shows for the subjects assigned to the five trajectory groups the mean numbers of self-reported offenses over the period from 14 to 20 years.[4] These figures are shown for males, females, and the total sample. The results in Table 4 show clear variations in total offending for members of different trajectories.

1. The low-risk trajectory (Group 1) had a predictably low rate of offending and reported an average of 1.6 offenses over the period from 14 to 20 years. These rates were similar for males and females.

2. Rates of offending were somewhat higher for the early adolescent onset offenders, who reported a mean of 4.8 offenses over the period from 14 to 20 years. For this group, the rate of offending by females (6.5) appeared somewhat higher than the rate for males (1.9).

3. The intermediate onset adolescent-limited group (Group 3) had a far higher rate (48.8) than for Groups 1 and 2. Rates of offending for males (48.4) and females (49.8) were similar.

4. The late onset adolescent-limited offending group had an offending rate (24.1) that was higher than Groups 1 and 2 but lower than the intermediate onset adolescent offending group. Rates of offending appeared to be somewhat higher for females (33.8) than for males (23.7). However, this comparison

3. A consequence of the fact that the assignment rates do not assign individuals to groups with 100% accuracy is that the percentages of individuals assigned to groups may differ somewhat from the estimated probabilities of group membership shown in Table 3.
4. Self-report measures of offending obtained at ages 11–13 years assessed offending diversity (the number of different types of offense committed) rather than offending frequency. At ages 14, 15, 17, and 20 years, both offending diversity and frequency were assessed. For this reason, the measure of offense frequency used here is limited to a count of the number of reported offenses for ages 14, 15, 17, and 20 years.

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Table 4. *Mean number of (self-reported) offenses (14–20 years) by trajectory group assignment*

Group	Male		Female		Total	
	N	Mean Offenses	*N*	Mean Offenses	*N*	Mean Offenses
Low-risk offenders	195	1.5	347	1.7	542	1.6
Early onset adolescent-limited offenders	51	1.9	87	6.5	138	4.8
Intermediate onset adolescent-limited offenders	44	48.4	15	49.8	59	48.8
Late onset adolescent-limited offenders	102	23.7	4	33.8	106	24.1
Chronic offenders	43	159.8	8	47.6	51	141.1
Total	435	26.4	461	5.2	896	15.5

is of limited precision as only 4 females were classified as members of this group.

5. The chronic offender group (Group 5) clearly had a frequency of offending that was dramatically higher than other groups. Over the period from 14 to 20 years, members of this group reported an average of 141.1 offenses or 35.3 offenses per year. Rates of offending appeared to be substantially lower among females (47.6) than males (159.8), but this comparison is of limited precision owing to the fact that only 8 females were classified as chronic offenders.

To test the extent to which offending rates varied with trajectory group, gender, and Gender × Trajectory Group, a negative binomial regression model was fitted to the data in Table 4. Negative binomial regression was used because of the highly skewed distributions of offense reports. This analysis revealed the following:

1. A highly significant effect for trajectory group, $LR\ \chi^2\ (4) = 273.0$, $p < .0001$, reflecting the marked differences in offending frequency for members of different trajectories.

2. No significant effect for gender, $LR\ \chi^2\ (1) = 1.5$, $p > .20$. This result indicates that when due allowance is made for trajectory group, rates of offending do not vary with gender.

3. No significant Gender × Trajectory Group interaction, $LR\ \chi^2\ (4) = 6.4$, $p > .10$. This finding suggested that the ways in which offending varied with trajectory groups did not differ with gender. The absence of a significant gender main effect and Gender × Trajectory Group interaction implies that the apparent gender differences in offending rates within trajectories in Table 4 are consistent with the view that these differences are due to chance variation rather than systematic gender differences.

Gender, childhood factors, and offending trajectories

Although the results in Tables 3 and 4 suggest that males and females followed similar trajectories in the development of offending and within trajectory groups have similar rates of offending, it is also of interest to examine the extent to which the correlates of female offending trajectories differ from the correlates for male offending trajectories. This issue is examined in Table 5, which shows the relationship between membership of the five offending trajectory groups and a series of risk factors that include measures of family sociodemographic background, family functioning, and individual characteristics. For each variable considered the table reports on tests of (a) the overall association between the risk factor and trajectory group membership and (b) Gender × Risk Factor interaction. The test of interaction ascertains whether the relation-

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Table 5. *Comparison of offending trajectory groups on measures of social, family, and individual characteristics*

Risk Factor (%)	Low-Risk Offenders (N = 542)	Adolescent-Limited Offenders			Chronic Offenders (N = 51)	Tests of Significance	
		Early Onset (N = 138)	Intermediate Onset (N = 59)	Late Onset (N = 106)		Risk Factor	Risk Factor × Gender
Sociodemographic background							
Mother aged <25 years at birth of child	32.3	44.2	50.9	47.2	60.8	<.0001	>.30
Mother lacked formal educational qualifications	45.8	53.6	47.5	46.2	66.7	<.05	>.60
Family of semiskilled, unskilled socioeconomic status	20.5	26.1	20.3	25.5	56.9	<.0001	>.05
Below-average family living standards (0–10 years)	18.1	25.4	18.6	27.4	54.9	<.0001	>.70
Family functioning							
Two or more changes of parents (0–10 years)	13.6	22.8	27.6	20.2	39.6	<.0001	>.10
In highest quintile on parental conflict score (0–10 years)	12.8	28.9	34.6	22.7	51.1	<.0001	>.50
Parental history of criminality	7.0	16.1	22.0	15.1	37.3	<.0001	>.10
Parental alcoholism or problems with alcohol	8.3	14.6	17.0	16.0	29.4	<.0001	>.05
Parental illicit drug use	19.6	28.3	30.5	22.6	49.0	<.0001	>.40
Individual factors							
In lowest quartile on child IQ score (8 years)	20.4	25.9	26.5	22.6	56.1	<.0001	>.70
In lowest quartile on self-esteem score (10 years)	18.1	38.3	18.2	25.9	50.0	<.0001	>.05
In highest quartile on novelty-seeking score (16 years)	21.1	25.9	54.4	31.1	38.8	<.0001	>.70

ship between the risk factor and trajectory membership varied with gender. The overall test of association for each risk factor was obtained by fitting a main effects multinomial logit model involving each of the trajectory groups, each risk factor, and gender. The test of interaction was obtained from the residual log likelihood ratio chi square for each model after the main effects of the risk factor and gender had been taken into account.

The table shows that trajectory membership was related to a wide range of social, family, and individual factors. As a general rule, the low-risk offender group had the most favorable profile of scores on these variables, those following a chronic offending trajectory had the least favorable profile, and those showing an adolescent-limited trajectory had an intermediate profile of risk factors.

Inspection of the table shows that the relationship between risk factors and trajectory group membership appeared to be similar for males and females. Of the 12 tests of gender interaction reported in Table 5, all were nonsignificant.

To examine the net effects of the risk factors in Table 5 on trajectory group membership a multinomial logit model was fitted to the data. This model suggested that six risk factors made net contributions to trajectory group membership. These factors were gender, $LR\ \chi^2\ (4) = 73.0$, $p < .0001$, parental criminality, $LR\ \chi^2\ (4) = 12.0$, $p < .05$, parental conflict, $LR\ \chi^2\ (4) = 31.5$, $p < .0001$, novelty seeking, $LR\ \chi^2\ (4) = 35.1$, $p < .0001$, IQ, $LR\ \chi^2\ (4) = 18.9$, $p < .001$, and self-esteem, $LR\ \chi^2\ (4) = 29.6$, $p < .0001$. Broadly speaking, these results suggested that increasing tendencies to criminality were associated with male gender, parental criminality, parental conflict, tendencies to novelty-seeking behaviors, low intelligence, and low self-esteem.

The analysis was then extended to examine whether the effects of these risk factors on trajectory memberships varied with gender. This involved comparing the fit of multinomial logistic models in which (a) the parameters for a specific risk factor were set equal for gender groups or (b) the parameter values were free to vary with gender. This comparison gave a log likelihood ratio test ($df = 4$) of the extent to which the parameter values for a specific risk factor differed across gender groups. In all cases, there was no evidence to suggest that model parameters varied significantly with gender.

In summary, the multinominal logit analysis suggested that six factors (gender, parental criminality, parental conflict, novelty seeking, IQ, self-esteem) were predictive of the offending trajectory children followed. The effects of these risk factors on offending trajectory did not differ with gender, suggesting that the circumstances that placed females at risk of following a given offending trajectory were similar to the circumstances that placed males at risk of following this trajectory. However, females were less predisposed to crime and, particularly, to following a later onset or chronic offending trajectory.

Supplementary analyses

The above analyses have examined trajectory data for overall risks of violent or property offending. However, it could be argued that the trajectories for violent offending may be different from those for property offending. To examine this issue, the data were reanalyzed to fit separate trajectory models for violent and property offending. This analysis produced conclusions that were very similar to the analysis of the combined property and violent offending data.

First, for both property and violent offending a five-group latent class model appeared to provide the best fit to the data. In each case, the five latent trajectories identified appeared to have a similar interpretation to the trajectory groups identified in the analysis of the combined offending data; that is, for both violent and property offending it was possible to identify a group of low-risk offenders, three groups of adolescent-limited offenders (corresponding to early, intermediate, and late onset), and a group of chronic offenders. In addition, in each case the best-fitting model was one in which offending rates were set equal but group membership probabilities were permitted to vary across gender. Table 6 shows the proportion of males and females assigned

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Table 6. *Estimated probabilities* (*standard errors*) *of latent class membership for five class models fitted separately for property and violent offending*

Group	Property Offending		Violent Offending	
	Males	Females	Males	Females
Low-risk offenders	.429 (.044)	.766 (.035)	.590 (.047)	.869 (.027)
Early onset adolescent-limited offenders	.079 (.031)	.125 (.027)	.112 (.026)	.084 (.021)
Intermediate onset adolescent-limited offenders	.141 (.036)	.063 (.020)	.113 (.030)	.032 (.011)
Late onset adolescent-limited offenders	.253 (.060)	.025 (.022)	.151 (.058)	.012 (.018)
Chronic offenders	.097 (.018)	.021 (.008)	.034 (.010)	.002 (.002)

to each group for the two types of offending. Examination of the table shows the following:

1. For both property and violent offending the proportion of males and females assigned to the low-risk offender group was higher than the proportions given in Table 3, reflecting the lower base rate of offending in the cohort when the different types of offending were considered separately.

2. In each case, a similar pattern of gender differences is apparent, with the great majority of females assigned to the low-risk and early adolescent onset groups and a substantial minority of males assigned to the intermediate or later adolescent onset trajectories or chronic offender trajectories.

Second, analysis of the risk factors associated with trajectory group membership showed an identical pattern of results for violent and property offending. In particular, for both types of offending the low-risk offender group generally had the lowest levels of exposure to adverse social, family, and individual circumstances, the adolescent-limited groups had intermediate levels of exposure, and the chronic offender group the highest levels of exposure to these factors. In all cases, there was no evidence that the association between the risk factor and trajectory group membership varied with gender, suggesting that the same pattern of risk factors operated in the same way for both males and females for both types of offending.

Discussion

In this study we have used data gathered over the course of a 21-year longitudinal study of a New Zealand birth cohort to examine the extent to which (a) males and females followed similar offending trajectories and (b) the risk factors for offending trajectories varied with gender. The major findings of this study and their implications are discussed below.

Gender and offending trajectories

The present study has made it possible to address two issues relating to offending trajectories. First, it was possible to explore the extent to which the data gathered in this study supported the distinction between early onset life-course-persistent offending and later onset adolescent-limited offending. In general, the results clearly show the presence of a relatively small group of the cohort (9.4% males, 2.1% females) who showed a chronic pattern of offending that extended from early adolescence into young adulthood. Members of this trajectory were characterized by high rates of conduct problems in middle childhood, continued offending throughout adolescence, and high total offending rates, with members of this group reporting an average of 35 offenses per year. This trajectory group has features that are generally consistent with accounts of the early onset life-course-persistent offender group. However, the trajectory for this group also showed a tendency for offending to reduce at age 21 years, perhaps suggesting that

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even among the chronic offender group there may be a tendency to desistance with increasing maturity.

The study also supported the claims about the presence of late onset adolescent-limited offending to the extent that the analysis identified three offending trajectories in which rates of offending increased during adolescence and then declined. The first trajectory showed a pattern of early adolescent onset that peaked at the age of 13 years and declined thereafter. The second group showed an intermediate pattern of onset that began at age 13 years, peaked at age 17 years, and declined thereafter. The third group showed a generally low to moderate rate of offending up to age 15 years, with a sharp increase in offending at age 17 years, followed by a decline at age 20 years. Clearly, all three groups represent some form of "adolescent-limited" offending in which rates of offending peak in adolescence and then decline before age 21 years. What this finding suggests is that those who have been described in previous research as "adolescence-limited" offenders are unlikely to be a single homogeneous group and may vary in the age of onset of offending and the duration of offending, with the result that it is possible to identify early, intermediate, and late onset patterns of adolescent-limited offending. The developmental significance and correlates of the age of onset of adolescent-limited offending trajectories remain to be explored. However, the fact that females tend to predominate in the early onset group, whereas males predominate in the later onset groups, may suggest that factors such as the onset of puberty and social maturity may play a role in this timing. There is clearly a need to replicate the present findings on the age of onset at adolescent-limited offending and to explore the developmental correlates of differences in age of onset.

An important issue raised by Silverthorn and Frick (1999) concerned the extent to which males and females followed different offending trajectories. In particular, Silverthorn and Frick (1999) argue that the early onset life-course-persistent pathway does not exist for females and that female offending follows a single delayed onset pathway. The findings of this study do not support this conclusion in general. For all analyses conducted (total offenses, property offenses, and violent offenses), there was evidence of an early onset chronic offending pathway and three adolescent-limited pathways for both males and females. What distinguished males and females was not the presence or absence of an early onset pathway but rather the fact that far fewer females followed this pathway (with female chronic violent offending being particularly rare). Although the findings do not support Silverthorn and Frick's claim that females do not follow the early onset life-course-persistent pathway, they do show that only a small minority of females follow this pathway and that the majority of female offending is of adolescent onset with the most common female offending trajectory being early onset adolescent-limited offending.

More generally, the results of the latent trajectory analysis suggested that males and females followed the same or very similar offending trajectories. *What distinguished male and female trajectory models was not the shape of the offending trajectories but rather the fact that there were marked gender differences in the fractions of young people following different offending trajectories, with females being most likely to follow low offending risk and early adolescent-limited pathways and males being more likely to follow chronic offending or later adolescent-limited offending pathways.*

Correlates

A key assumption of trajectory theories of crime has been that different trajectories reflect the presence of different correlates and aetiological factors. Thus early onset life-course-persistent offending patterns have been linked to pathological social, individual, or family conditions (Moffitt, 1993; Moffitt et al., 1996; Patterson, 1996; Patterson et al., 1998), whereas late onset–adolescence-limited offending has been linked to processes of social mimicry and peer influence (Fergusson, Horwood, & Nagin, 2000; Moffitt et al., 1996; Patterson & Yoerger, 1997). However,

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the present study suggests the presence of a broad range of social, family, and individual factors that appear to exert a common influence on offending trajectories. In particular, the multinomial logistic model fitted to the data suggested that trajectory memberships were determined by a series of factors that included gender, parental criminality, parental conflict, novelty seeking, IQ, and self-esteem. The findings suggest that increasing criminality was associated with male gender, parental criminality, exposure to parental conflict, tendencies to novelty-seeking behavior, low IQ, and poor self-esteem. In this respect, the findings of this study accord well with previous studies of the risk factors for crime (see, e.g., Farrington et al., 1990).

An important issue in the literature on the etiology of crime has focused on the extent to which the risk factors and life processes that give rise to female crime differ from those associated with male crime (Fergusson, Woodward, & Horwood, 2000; Giordano & Cernkovich, 1997; Keenan & Shaw, 1997; Silverthorn & Frick, 1999; Zoccolillo, 1993). The present study has provided an opportunity to address this issue by examining the extent to which risk factors for male offending trajectories were similar to (or different from) the risk factors for female offending trajectories. The present analysis found no differences in the risk factors for offending behaviors, with the risk factors for female offending trajectories being very similar to the risk factors for corresponding male trajectories.

Study limitations

There are two potential limitations to the findings reported in this paper. First, because late onset and chronic offending were uncommon among females, the study had limited statistical power to (a) test gender differences in offending trajectories and (b) test gender differences in the correlates of offending trajectories. It is possible that with a larger sample, gender differences in offending trajectories and correlates may have been observed. This conclusion highlights the need for gender comparisons of offending trajectories to be based on large samples in order to obtain precise estimates of gender similarities and differences. Second, a number of correlates examined in this study are based on self- or parental report data that was ascertained concurrently with the assessment of offending. It is possible that the reporting of these data may have been colored by knowledge of the young person's offending behaviors.

Notwithstanding the limitations discussed above, the analysis suggests three major conclusions about gender differences in offending within this cohort:

1. Males and females appear to follow a similar set of trajectories in the development of crime.
2. The correlates of male and female offending trajectories appear to be very similar, suggesting that the psychosocial circumstances and factors that place males at risk of crime also act to place females at risk of crime.
3. Males and females were, however, distinguished by the fact that the rate of offending among females was approximately 50% of the rate among males. This difference in overall offending rates was reflected in the facts that (a) more females than males followed a low-risk offending trajectory, (b) more females than males followed an early onset adolescent-limited trajectory, and (c) far more males than females followed the chronic and late onset adolescent-limited trajectories.

These conclusions are, of course, specific to the measures of offending and risk factors used in this study, and results may vary for other cohorts, measures of offending, or risk factors.

The clear impression that emerges from this analysis is that the general developmental sequence and etiological factors associated with female offending are similar to the development and etiology of male offending. However, the two gender groups are distinguished strongly by the fact that females are less predisposed to offend than males, and this is reflected very clearly in the far smaller group of females who show a life-course-persistent pattern of offending.

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