

Criminality and antisocial behaviour in unselected men with sex chromosome abnormalities

[Original Articles]

GOTZ, M. J.; JOHNSTONE, E. C.; RATCLIFFE, S. G.

From the Department of Psychiatry, Royal Edinburgh Hospital, Edinburgh; and Institute of Child Health, London.

(GOTZ) Address for correspondence: Dr Michael J. Gotz, Kildean Day Hospital, Drip Road, Stirling FK5 1RN.

---

Outline

- [ABSTRACT](#)
- [INTRODUCTION](#)
- [METHOD](#)
  - [The Newborn Cytogenetic Survey - the basis of the present study](#)
  - [The present study](#)
  - [Statistical analysis](#)
- [RESULTS](#)
  - [XYY men](#)
    - [Antisocial personality disorder](#)
    - [Criminal records](#)
    - [Alcohol consumption](#)
  - [XXY men](#)
    - [Antisocial personality disorder](#)
    - [Criminal records](#)
    - [Alcohol consumption](#)
- [DISCUSSION](#)
- [REFERENCES](#)

Graphics

- [Figure 1](#)
- [Equation 1](#)
- [Equation 2](#)

- [Equation 3](#)
  - [Table 2](#)
  - [Table 1](#)
  - [Table 3](#)
  - [Table 4](#)
  - [Table 5](#)
  - [Table 6](#)
  - [Table 7](#)
- 

## ABSTRACT

**Background:** Previous studies on male patients with sex chromosome abnormalities (SCA), namely XYY and XXY, suggest that such patients commit criminal acts more frequently than expected. Most of these studies are affected by ascertainment bias.

**Methods:** Using a population-based sample of men with SCA, identified by screening 34 380 infants at birth between 1967 and 1979, comparison between 16 XYY men, 13 XXY men and 45 controls were made in terms of frequency of antisocial personality disorder (APD) using the Schedule for Affective Disorders and Schizophrenia lifetime version. Rates of criminal convictions were examined in 17 XYY men, 17 XXY men and 60 controls.

**Results:** XYY males showed a significantly higher frequency of antisocial behaviour in adolescence and adulthood and of criminal convictions than the controls, but multiple regression analysis showed this to be mediated mainly through lowered intelligence. Property offences constituted the majority of offences in all groups. The XXY men did not show an increased rate of criminal convictions. It is possible that this apparently negative result relates to the relatively small numbers of cases and hence low power of this study.

**Conclusions:** The findings of this study carry the advantage of not being affected by ascertainment bias and the disadvantage of having low power. It provides evidence for a slightly increased liability to antisocial behaviour in XYY men.

---

## INTRODUCTION

The incidence of sex chromosome abnormalities (SCA) is 1.3 per 1000 male births for XXY and 1.0 per 1000 for XYY, hence assuming a steady frequency over time there will be about 30 000 XXY and 25 000 XYY men in the UK population. Knowledge of the susceptibility to and the pattern of psychiatric disorders in individuals with SCA is of relevance to psychiatrists and genetic counsellors (Ratcliffe, 1994) [23]. The purpose of this study was to examine the level of antisocial behaviour and criminality in young men with SCA using a population-based sample. The criminal records of 17 XYY men and 17 XXY men identified in a newborn cytogenetic survey (Ratcliffe et al. 1986) [21] are compared with 60 chromosomally normal controls from the same population. In addition, the results of a standardized interview conducted with 16 of the XYY men, 13 of the XXY men and 45 of the control subjects are

reported.

Studies of men with SCA conducted during the 1960s and early 1970s suggested that affected individuals commit criminal acts more frequently than expected. This view, applied particularly to XYY men, arose initially as a consequence of cytogenetic surveys of men in the State Hospital in Carstairs (Jacobs et al. 1965) [12] for 'mentally ill or mentally impaired with dangerous, violent or criminal propensities' (Mental Health (Scotland) Act 1984). Subsequently, other studies confirmed that XYY men, and to a lesser degree XXY men, were over-represented in such settings.

Virtually all of these studies have the disadvantage of ascertainment bias as the SCA cases were preselected for antisocial behaviour and/or height. The evidence suggests that the crimes that patients with SCA commit are not more violent than those by chromosomally normal offenders, and are against property rather than persons (Price & Whatmore, 1967; Casey et al. 1972; Hook, 1973; Witkin et al. 1976) [18,4,10,30]. Some, but not all patients with SCA suffer from mild neuropsychological impairment (Theilgaard, 1984; Ratcliffe, 1994) [27,23] and the role of such deficits in relation to criminal behaviour in the general population (West & Farrington, 1973) [29] and in patients with SCA is a matter of debate (Witkin et al. 1976) [30].

## METHOD †

The Newborn Cytogenetic Survey - the basis of the present study †

The Newborn Cytogenetic Survey carried out by the Medical Research Council in Edinburgh screened consecutive, liveborn infants for abnormal numbers of X and Y chromosomes between 1967 and 1979 (for details see Ratcliffe et al. 1986) [21]. Two of the four maternity hospitals in Edinburgh participated in the survey, representing about 35% of all births of the city. The total number of infants screened was 34 380; of whom 17 522 were males and 16 858 females.

Seventy infants were found to have a SCA, 50 males and 20 females. A control population of chromosomally normal infants was randomly recruited from the same maternity units between 1972 and 1976. The cases and the controls participated in a longitudinal study of their growth and development, attending a growth clinic every 3 months in the first year and then every 6 months. The studies included anthropometric and psychometric aspects (Ratcliffe et al. 1986, 1991; Ratcliffe, 1994) [21,22,23].

The present study †

The present study concerns evidence for antisocial behaviour and criminal behaviour in men with SCA as compared with controls. No cases with mosaicism were included. The original survey identified 18 XYY infants. An additional XYY boy was identified in a twin survey carried out in another maternity hospital, and one further XYY boy joined the study at age 5 having been identified in a newborn survey in the north of Scotland. One died shortly after birth of renal agenesis and thus data was available on 19 young XYY men. Their mean age was 22 (range 18-26).

Of the 23 XXY infants identified at birth, one died of extreme prematurity, two other infants emigrated in the first year of life and in one case the GP was not agreeable to follow-up at the hospital; in addition two subjects were less than 18 at the time of the interview, thus leaving 17 young men on whom data is presented here. Their mean age at interview was 21 (range 18-27).

Sixty controls were approached to take part in the study starting with the earliest recruited in 1972 in order to achieve the best comparability in terms of subject age. The mean age of the controls was 21 years

(range 20-26).

For the purpose of this study the cases and controls were personally interviewed at least once by one author (M. J. G.) who was unaware of their chromosomal status and their medical or sociocultural data. Data on the subjects' IQ and parental social class background were available from previous examinations of the cohort (Ratcliffe, 1994) [23].

The Schedule for Affective Disorders and Schizophrenia, lifetime version (Endicott & Spitzer, 1978) [6] was used to assess psychopathology yielding Research Diagnostic Criteria (RDC) diagnoses (Spitzer et al. 1977) [26]. This paper concerns evidence for antisocial personality disorder but it is worth noting that none of the SCA subjects fulfilled criteria for current major psychiatric disorder (Gotz, 1996) [8].

Antisocial personality as defined by RDC requires the 'failure to conform to social norms in many areas, beginning before the age of 15 and persisting into adulthood, in the absence of severe mental retardation'. There are 21 items relating to antisocial behaviour grouped under the following four headings.

1 Poor occupational performance: frequent job changes, unemployment (unaccounted for by economic fluctuations), absenteeism.

2 Antisocial behaviour in school: truancy, expulsion, underachievement, breaking rules, running away, lying, alcohol, stealing, vandalism, early sex.

3 Antisocial behaviour after leaving school: arrested, divorced, physical fights, drunkenness, debts, vagrancy.

4 Markedly impaired capacity to sustain lasting, close, warm and responsible relationships: closeness, mutual support, duration of friendships.

Each of the 21 items is answered with 'yes/no/no information' and antisocial personality is diagnosed if there is an affirmative response to a question in all four of the above categories. Official criminal records were provided by the Scottish Criminal Records Office, Glasgow.

Statistical analysis [↑](#)

Two by two contingency tables were used to compare the differences in prevalence rates for the diagnosis of antisocial personality disorder (RDC) between cases and controls. Odds ratios were calculated together with confidence intervals using Woolfs' formula for variance, followed by a two tailed Fisher's exact test to estimate mid P values and a logistic regression using the Wald statistic to examine the influence of the confounding factors 'social class' and 'IQ'. Data were analysed using the SPSS.

Estimates of criminal conviction rates were calculated by examining the numbers of subjects in each group having at least one criminal conviction during their life time before the end of October 1993. As the subjects differed in age (overall range 16-27 years) the time at risk for conviction varied for each individual. This was taken into account in a second calculation that took the 'person years at risk' for each group into account. Ten years of age is the earliest age for criminal responsibility in the UK. Therefore, only the years beyond the age of 10 were included to contribute to the score. As none of the subjects has died since inclusion in this study no adjustment for death was necessary. Adjustment was made for time in prison. Two cases emigrated early from the UK, they were therefore excluded from the calculation. To obtain rate ratios the data were first organized as a 2 x 2 contingency figure ([Figure 1](#)).

	Cases	Controls	Total
Convictions	$a$	$b$	$M$
Person years	$N_1$	$N_2$	$T$

Figure 1. No caption available.

Where,  $a$  represents the number of offences in the cases,  $b$  the number of offences in the controls.  $M$  the total number of offences,  $N_1$  and  $N_2$  the number of 'person years' contributed by the cases and the controls respectively. The rate ratio is the ratio of the two rates: (Equation 1), and the 95% confidence interval was calculated from the standard deviation of the rate ratio using Rothman's formula: (Equation 2). The expected number  $n$  of events per cases can be calculated as (Equation 3), and similarly so for the controls. The two ratios 'events per "person years"' could be compared with the expected 'events per "person years"' and a P value was obtained from the binomial distribution.

$$RR = (a/N_1)/(b/N_2),$$

Equation 1

$$S.D.(ln RR) = \sqrt{1/a + 1/b}.$$

Equation 2

$$n_1(exp) = M/T * N_1,$$

Equation 3

## RESULTS †

Sixteen (88%) of the XYY men, 13 (82%) of the XXY men and 45 (75%) of the male control subjects agreed to be interviewed. Controls who were not interviewed did not differ in terms of age (20.9 years v. 21.1 years), height (176.9 cm v. 176.1 cm), IQ (112.9 v. 110.1), social class distribution and rate of criminal convictions (3 out of 15 (20%) v. 5 out of 45 (11.1%)) from the controls who were interviewed. All subjects had left school by the time of the interview and the majority were in employment and a minority were in further education. The XXY men and the controls subjects did not differ in their social class distribution (as determined by parental social class) from the population of Edinburgh. As reported previously (Ratcliffe & Evans, 1975) [19] the XYY men included more subjects in social class I and II (47%) and fewer subjects in the lower social classes (6%). In view of the method of identification of the subjects by screening consecutive liveborn infants there is no reason to suspect ascertainment bias to

explain this, and at present no satisfactory explanation is available.

No patient was found to fit diagnostic criteria for major psychiatric disorder. Details of issues relating to general psychopathology will be presented elsewhere. Significant findings regarding the diagnosis of antisocial personality disorder were found and are presented here together with items from the SADS-L relevant to antisocial behaviour.

### XYY men [†](#)

#### Antisocial personality disorder [†](#)

Eleven of the 16 XYY men experienced more frequent job changes than the controls ( $P < 0.02$ ) and 47% of them had frequent (twice or more per month over past 6 months) absences from work compared with 20% of the controls. Forty per cent had periods of unemployment for more than 3 months at a time, as had 29% of the controls ([Table 2](#)). The XYY men stated, that their school careers could have run more smoothly and more successfully and more XYY men than controls thought that they could have done better at school ( $P < 0.01$ ), they admitted to lying more frequently at home and at school ( $P < 0.001$ ) and to more frequent disruptive behaviour at school ( $P < 0.005$ ). There were no differences in the self-reported rates of truancy, expulsion from school or criminal damage. Occasional truancy, particularly during the latter years of school were reported by about one-third of all boys. Reported alcohol use in childhood, adolescence and in adulthood was increased in the XYY men, with a median weekly alcohol consumption of 30 units in the XYY men compared with 10 units in the controls ( $P < 0.05$ ).

	Cases ( <i>N</i> = 16) <i>N</i> (%)	Controls ( <i>N</i> = 45) <i>N</i> (%)	Odds ratio (95% CI)	<i>P</i> value (Fisher's exact test)
Unstable occupational history	11 (69)	15 (33)	4.40 (1.29 to 14.99)	0.02
Antisocial behaviour in adolescence	12 (75)	12 (27)	8.25 (2.33 to 30.59)	0.001
Antisocial behaviour in adulthood	10 (65)	11 (24)	5.15 (1.52 to 17.44)	0.01
Antisocial personality disorder (RDC)	6 (38)	6 (13)	3.90 (1.03 to 14.71)	0.14

Table 2. Antisocial behaviour in XYY men and controls

Thirty-eight per cent of the XYY men and 13% of the controls fulfilled RDC for antisocial personality disorder (APD) (see [Table 1](#)). Within social class III, IV and V about one half of the XYY men had APD compared with one-sixth of the controls. A more detailed examination of the relationship between social class and APD is not possible due to the small numbers.

Study	Type of study	Subjects screened (N)	Subjects with SCA found (N)	Principal findings	Strengths	Weaknesses
Court Brown <i>et al.</i> (1964)	Miscellaneous referrals	?	99 men	14 psychiatric in-patients, 5 schizophrenics	Pioneering	Ascertainment bias
Jacobs <i>et al.</i> (1965)	Survey of mentally subnormal patients in Carstairs State Hospital	197	7 XYY 1 XXYY 1 mosaic	Assumed excess over populations rate for XYY	Pioneering	Ascertainment bias
Casey <i>et al.</i> (1966)	Sex Chromatin survey of Rampton and Moss Side Hospitals	942	12 XXY 7 XXYY 2 mosaics	Excess of sex chromatin positive males at Rampton and Moss Side compared with an institutionalized mentally subnormally population where violent behaviour is not a feature	Large numbers pioneering	Ascertainment bias (XYY would not be detected)
Jacobs <i>et al.</i> (1968)	Survey of Carstairs hospital both mentally subnormal and mentally ill	315	9 XYY 1 XXYY 1 XXYY	Incidence of XYY of 2.9% higher than population		Ascertainment bias
Casey <i>et al.</i> (1972)	Chromosome survey of Rampton, Moss Side Hospitals	615	32 XYY 18 XXYY 7 XXYY	Predisposition of SCA men criminal behaviour may be secondary to mental subnormality and family background	Pioneering. Detailed social background of cases and controls	Ascertainment bias
Hook (1973)	Review of 35 studies in mental/penal settings and newborn	3813 and 3825	82 XYY and 3 XYY	Approximately 20-fold increase in XYY men in mental penal settings over newborn incidence	Large numbers	Population studied varied in criteria for admission to institutions
Witkin <i>et al.</i> (1976)	Population-based study restricted to top 16% by height	4139	16 XXY 12 XYY	Rate of criminal convictions: XYY 42%, XXY 19%, XY 9%	Population-based and well controlled	Height restriction
Hunter (1977)	Screening of all male patients from 18 hospitals for the mentally handicapped in Sheffield area	1811 men	12 XYY men	7 of 10 XYY men had a criminal record compared with 4 of 10 IQ matched controls from same hospitals	Controlled study	No statistical analysis offered, ascertainment bias
Nielsen <i>et al.</i> (1980)	Attendees at endocrinology clinic	?	34 XXY men	Self-reported rate of criminal behaviour at age 26 higher among XXY men than among hypogonadal XY controls; no difference at age 35	Well controlled	Self-report only
Schroder <i>et al.</i> (1981)	Mentally abnormal offenders	1040 men	9 XYY men 11 XXY men	Types of crimes committed by subjects with SCA same as by chromosomally normal subjects from same cohort	Comparatively large cohort	Selection bias, no statistical analysis

Table 1. Review of the literature

No statistically significant difference was found between the measured IQ (WAIS, full scale score) of those XYY men with the diagnosis of APD compared with those without (chi squared test, 95 v. 102,  $P = 0.5$ ). In the controls however the IQ differed significantly between those diagnosed as having APD and those without (97.2 v. 111.9,  $P < 0.01$ ). The cases and controls with APD did not differ significantly from each other in their mean IQs, despite the XYY men as a group having significantly lower IQ scores than the social class matched controls, as had the case and control subgroups free from APD.

#### Criminal records [↑](#)

Five (29%) of the 17 XYY men had at least one official criminal conviction ([Table 3](#)) compared to seven of the 60 controls ( $P = 0.11$ ). One XYY subject who lives abroad reported criminal convictions. Due to a lack of official records those self-reported convictions were not included in the calculation. Three of the cases and four of the controls had more than three convictions ( $P = 0.22$ ).

Criminal convictions	Cases (N = 17) N (%)	Controls (N = 60) N (%)	Odds ratio (95% CI)	P value (Fisher's exact test)
At least 1	5 (29)	7 (12)	3.15 (0.85 to 11.66)	0.11
> 3	3 (18)	4 (7)	3.00 (0.60 to 14.97)	0.22

Table 3. Criminal convictions in XYY men and controls

Adjusting for the number of years at risk of receiving a criminal conviction, [Table 4](#) shows the rate ratios for convictions. The difference in overall delinquency rate ratios was significant at the 1% level revealing that the XYY men were more likely to have a criminal record than chromosomally normal controls. One of the XYY subjects reported at interview to have received a criminal conviction which we have no official record on. Another XYY subject reported to having been questioned and to having admitted to an arson offence outwith the UK. Both offences were not included in the calculation; had they been the difference between cases and controls would have been more significant.

Offence	Cases (189-40 accum. years)	Controls (664-91 accum. years)	Rate ratio (95% CI)	<i>P</i>
Assault	4	5	2.81 (0.75 to 10.46)	0.2
Breach of peace	11	11	3.51 (1.52 to 8.10)	0.005
Theft	11	12	3.22 (1.42 to 7.29)	0.01
Criminal damage	0	2		
Alcohol and drugs	0	0		
Road traffic	3	24	0.44 (0.13 to 1.46)	0.3
Sexual	2	0		
Other	5	22	0.80 (0.30 to 2.11)	0.23
All offences	36	76	1.66 (1.12 to 2.47)	0.01

Table 4. Rate ratio for convictions in XYY men and controls by offence category

The seven main categories of convictions: 'assault', 'theft', 'criminal damage', 'alcohol and drug related', 'road traffic', 'sexual offences' and other offences are shown in [Table 4](#). 'Breach of peace' was listed as a separate entity to allow some distinction between mostly minor and more substantial offences. The XYY men committed more offences overall ( $P < 0.01$ ), in particular within the categories 'breach of peace' ( $P < 0.005$ ) and theft ( $P < 0.01$ ). The other subcategories did not reveal any significant differences.

How serious were the offences? There was no solemn court procedure against the cases or controls neither was there any evidence from the sentences imposed on the subjects, that the offences committed by the XYY men were more serious than those committed by the controls. Only one subject, a control, carried a weapon and was convicted of armed robbery. He received a sentence of 4 years in a high security prison, the longest of all sentences. The crimes of a sexual nature were indecent assault and shame-less indecency. The majority of convictions involved fines of the order of [pound sign]20 to [pound sign]100 or community service orders. The XYY men received their first conviction at a mean age of 17.6 (S.D. = 2.80) years, not significantly younger than the controls at 18.1 (S.D. = 3.05).

Consideration of the influence of social class on the rate of recorded delinquency must take into account the fact that the social class distribution of the XYY men was shifted towards higher levels of skill based on the occupations of their fathers. Only one of the five XYY men with convictions came from social class 4 or 5, compared with three of the seven controls with a record of criminal conviction. Both groups had one subject who was responsible for a disproportionate number of convictions. One XYY man accounted for almost half of the cases' convictions and one control for exactly half of the control group's convictions.

As with APD the influence of the subject's IQ on the rate of criminal conviction was important. Both cases and controls with convictions showed significantly lower IQs than those without (XYY 90 v. 96,  $P < 0.02$ ;

controls 101 v. 112,  $P < 0.01$ ). A logistic regression model was fitted with criminal conviction (absence or presence) as the dependent variable and social class, IQ and karyotype (XYY or XY) as independent variables (Table 5). The result shows that IQ contributes significantly to the likelihood of having a conviction ( $P < 0.01$ ), but that social class and karyotype does not. However, as the presence of an additional Y chromosome is associated with a small adverse effect on cognitive abilities, it would appear that this is the pathway leading to an increase in convictions rather than some other characteristics of the karyotype.

Variable	Wald	df	<i>P</i>
IQ (WAIS-R)	7.37	1	0.01
Social class (I–V)	1.79	4	0.77
Karyotype (XYY or XY)	1.68	1	0.20

Table 5. Logistic regression: XYY men with or without a criminal conviction as dependent variable and social class, IQ and karyotype as independent variables

#### Alcohol consumption [↑](#)

The XYY men reported a median weekly alcohol consumption of 30 units (range 2-200) compared with 10 units (range 0-160) for the controls and nine of them reported drinking > 21 units of alcohol per week. Binge drinking was more common among the cases. Twenty-seven per cent of the XYY cases can be defined as alcohol dependent according to RDC compared with 7% of the controls (NS). In addition, 20% of the XYY men reported regular use of illicit drugs to a clinically significant degree but this was not significantly more than in the controls (odds ratio 2.56, CI, 0.50 to 13.07,  $P = 0.35$ ).

#### XXY men [↑](#)

##### Antisocial personality disorder [↑](#)

While XXY young men showed increased antisocial behaviour in adolescence ( $P < 0.01$ ) and a more unstable occupational history ( $P < 0.03$ ) there was no significant excess in the numbers with a diagnosis of APD (Table 6). XXY men did not truant more often, they were not expelled from school more often and they did not admit to lying more frequently.

	Cases ( <i>N</i> = 13) <i>N</i> (%)	Controls ( <i>N</i> = 45) <i>N</i> (%)	Odds ratio (95% CI)	<i>P</i> value (Fisher's exact test)
Unstable occupational history	9 (69)	15 (33)	4.50 (1.19 to 17.03)	0.03
Antisocial behaviour in adolescence	9 (69)	12 (27)	6.19 (1.60 to 23.88)	0.004
Antisocial behaviour in adulthood	6 (46)	11 (24)	2.65 (0.73 to 9.58)	0.1
Antisocial personality disorder (RDC)	3 (23)	6 (13)	1.95 (0.41 to 9.19)	0.43

Table 6. Antisocial behaviour in XXY men and controls

In summary, there is some evidence for moderate occupational instability and for antisocial behaviour in adolescence, but little in adulthood and XXY men were not diagnosed as having APD more often than the controls. Among those with APD the mean IQ score ([Table 2](#)) did not differ from that of the controls with APD (91.0 v. 97.2, NS), although the group of XXY men as a whole as well as the subgroup of XXY men without APD were of lower IQ than the controls. The small number of XXY men with APD precluded examination of any social class effect.

### Criminal records [†](#)

Only two of the XXY men had criminal convictions ([Table 7](#)). Nine of the total of 10 offences were committed by one XXY man and he received fines for thefts, criminal damage and assaults, his first when he was aged 16. His IQ was 77, he came from social class III but was not available for interview. His family background is likely to be relevant as he was the younger brother of the control with the most numerous and serious offences. The other XXY man had a single conviction for a breach of peace. He had an IQ of 91, came from social class III and was given a diagnosis of APD at interview. None of the criminal convictions were for a sexual offence and there were no solemn procedures.

Criminal convictions	Cases ( <i>N</i> = 17) <i>N</i> (%)	Controls ( <i>N</i> = 60) <i>N</i> (%)	Odds ratio (95% CI)	<i>P</i> value (Fisher's exact test)
At least 1	2 (12)	7 (11.7)	1.01 (0.19 to 5.38)	0.5
> 3	1 (6)	4 (7)	0.88 (0.09 to 8.39)	0.5

Table 7. Criminal convictions in XXY men and controls

### Alcohol consumption [†](#)

XXY men reported a lower alcohol consumption than the controls - a median of 5 units per week, however, there was wide variability (0-40 units). None of the XXY men gave a history suggesting alcohol dependency or drug dependency.

### DISCUSSION [†](#)

Estimates of the prevalence of antisocial personality disorder range from 5 to 15% of the population depending on the criteria and sampling methods (Sadock, 1989) [\[24\]](#). In this study 13% of the controls were given such a diagnosis which is well within this range. There is evidence, that by using the SADS-L interview the results tend to yield false negative rather than false positive rates (Kosten & Rounsaville, 1992) [\[15\]](#). It is widely accepted that delinquency has to be seen as the result of a complex interaction between the individual and his environment influenced by factors that may be genetic (Cadoret & Stewart, 1990) [\[2\]](#), psychodevelopmental (Farrington, 1993) [\[7\]](#) and social (Kolvin et al. 1988) [\[14\]](#). The incidence of SCA is not higher among lower social class families (Ratcliffe & Evans, 1975; Walzer & Gerald, 1975) [\[19,28\]](#). Hence, offending behaviour in individuals with SCA cannot be explained on the basis of social class disadvantage.

In this study the difference in frequency of men with criminal convictions between cases and controls appears to be related mainly to lower IQ as seen from the logistic regression analysis. Factors such as style of parenting, marital discord or breakdown and parental psychiatric disorder, which increase or decrease

the incidence of antisocial behaviour, are not addressed here. Whether or not an individual acquires a criminal conviction is the result of a long sequence of events with multiple points at which divergence may occur, leading towards or away from conviction. Self-reported criminal convictions that do not appear in the official records were not included in the calculation. Had such data been included the odds ratio for XYY men to have a criminal conviction would have been greater. It was, of course, not possible to know exactly how often the subjects in fact engaged in behaviour that could have led to a conviction.

This study confirms previous reports of differences between XYY men and chromosomally normal men in respect of antisocial personality traits and criminal records. In XXY men neither the prevalence of APD nor the rate of criminal convictions was increased. When men with SCA were found in maximum security hospitals in the 1960s the nature of a possible association between SCA and delinquency was debated (Hook, 1973) [10]. Studies based on highly selective samples, such as those from maximum security hospitals, do not give true rates of antisocial behaviour for individuals with SCA as the criteria for admission to such settings varies in different countries. This is the first study on antisocial behaviour in patients with SCA that is not affected by such an ascertainment bias.

All individuals apprehended by the police do not necessarily progress to being taken to court. A selection bias may be introduced at this stage, with known recidivists or men who appear intimidating being treated more harshly. It has been hypothesized that tall stature, a characteristic of XYY men (Ratcliffe, 1994) [23], may increase the probability of being apprehended (Hunter, 1977) [11]. Similar factors may influence sentence practice and tall stature may be a factor here. Some papers have attempted to address the question of whether the tallness of XYY males contributes to their increased risk of institutionalization (Hook et al. 1973; Borgaonkar et al. 1972) [10,1] but were unable to reach definite conclusions due to the small numbers of XYY males investigated, all of whom came from institutions for mentally ill persons who had been in conflict with the law. From our data in which XYY males were identified by population screening the same trend to slightly shorter stature among the convicted compared with the unconvicted was found among the XYY males as in the controls (XYY convicted v. unconvicted, 188.1 cm v. 189.3 cm; XY convicted v. unconvicted, 175.5 cm v. 177.7 cm). It remains possible that increased height may lead to an increased likelihood of receiving a conviction in court.

After adjustment for age an increased rate of convictions was found among the XYY men. The nature of the delinquent behaviour differed from that in the controls in that there was an excess of convictions for breach of peace and theft among the XYY men, but there was no evidence from the length of imprisonment or the magnitude of the fines that the delinquent acts of the cases were more extreme than those of the controls. This is in agreement with studies by Casey et al. (1972) [4], Hook (1973) [10], Witkin et al. (1976) [30] and Schroder et al. (1981) [25]. The association between low IQ and delinquent behaviour has long been a topic of research (Glueck & Glueck, 1950) [9]. Lynam et al. (1993) [16] in a survey of delinquent behaviour in 508 boys, controlled for both social class and race, tested various hypothesis on the relationship between crime, social class, race, impulsivity, school achievement and intelligence. An inverse relation between measured IQ and delinquency was established, and findings pointed towards the direction of effect progressing from low IQ to delinquency. This effect is likely to be applicable to our cohort.

Witkin et al. (1976) [30] found an increased rate of criminality in XYY men even after adjusting for social class and intelligence. One characteristic of that study was that the population-based sample of SCA patients was identified by screening only men taller than 183 cm. The discrepancy between expected and diagnosed numbers of XYY men was considerable: assuming an incidence of 1 in 1000 of the male

population the study should have found at least 30 individuals in this cohort of 31 000 whereas in the height restricted group only 12 XYY men were found. There is a possibility that this resulted in an identification of a subgroup of SCA men who were more likely to receive a criminal conviction in court, perhaps because of perceived threat on account of their greater height.

The findings on this cohort of XYY men from the general population do not support the report by Price & Whatmore (1967) [18] on XYY men in maximum security hospitals in respect of an earlier age of first convictions and are in agreement with Casey et al. (1972) [4] who found a mean age of 17.3 years at first conviction in 19 XYY men compared with 17.7 in the controls. The XYY men did not show elevated rates of criminality, but in view of the small numbers in the study this negative result must be interpreted with caution. However, the findings are in agreement with those of Witkin et al. (1976) [30] and Nielsen & Pelsen (1987) [17].

In conclusion, this study on unselected men with SCA demonstrates an increase in antisocial and criminal behaviour in XYY men related to their lowered intelligence resulting from the chromosome abnormality. The study has the disadvantage of low power and only finds evidence of antisocial behaviour during adolescence in XYY men. Nonetheless, it does provide findings that are not affected by ascertainment bias. As results become available on the follow-up studies of the newborn cytogenetic surveys in the US, Canada, Denmark and Japan, in which 200 cases of SCA were identified, there should be sufficient numbers to enable more definitive statements to be made with regard to their prognosis in social adaptation. The investigation provides some reassurance that the enhancement of liability to criminal behaviour in XYY individuals is relatively limited.

The clinical aspect of this study was approved of by the Psychiatry/Clinical Psychology Research Ethics Sub-Committee of the Lothian Research Ethics Committee. We would like to thank all subjects participating in the study for their cooperation. Our thanks to Mr Andrews, Scottish Criminal Records Office, Glasgow for providing us with information on criminal records, to John Duffy for statistical advice and to Miranda Maxwell for data collection.

M. J. G. conducted this research as a Wellcome Research Registrar and additional funding was provided by the Project Grant from the Medical Research Council.

## REFERENCES

1. Borgaonkar, D. S., Unger, W. M., Moore, S. M. & Crofton, T. A. (1972). 47,XYY syndrome, height and institutionalization of juvenile delinquents. *British Journal of Psychiatry* 120, 549-550. [\[Medline Link\]](#) [\[Context Link\]](#)
2. Cadoret, R. J. & Stewart, M. A. (1990). Genetic and environmental factors in adoptee antisocial personality. *European Archives of Psychiatry and Neurological Science* 239, 231-240. [\[Context Link\]](#)
3. Casey, M. D., Segall, L. J., Street, D. R. K. & Blank, C. E. (1966). Sex chromosome abnormalities in two state hospitals for patients requiring special security. *Nature* 209, 641-642. [\[Medline Link\]](#)
4. Casey, M. D., Blank, C. E., McLean, T. M., Kohn, P., Street, D. R. K., McDougall, J. M., Gooder, J. & Platts, J. (1972). Male patients with chromosome abnormality in two state hospitals. *Journal of Mental Deficiency Research* 16, 215-256. [\[Medline Link\]](#) [\[Context Link\]](#)
5. Court Brown, W. M., Harnden, D. G., Jacobs, P. A., MacLean, N. & Mantle, D. J. (1964).

Abnormalities of the Sex Chromosome Complement in Man. HMSO: London.

6. Endicott, J. & Spitzer, R. L. (1978). A diagnostic interview. Archives of General Psychiatry 35, 837-844. [\[Medline Link\]](#) [\[Context Link\]](#)
7. Farrington, D. P. (1993). Childhood origins of teenage antisocial behaviour and adult social dysfunction. Journal of the Royal Society of Medicine 86, 13-17. [\[Medline Link\]](#) [\[Context Link\]](#)
8. Gotz, M. (1996). The Psychiatric Consequences of Sex Chromosome Abnormalities - A Cohort Study. M.Ph. thesis, University of Edinburgh. [\[Context Link\]](#)
9. Glueck, S. & Glueck, E. T. (1950). Unraveling Juvenile Delinquency. Harvard University Press: Cambridge, MA. [\[Context Link\]](#)
10. Hook, E. B. (1973). Behavioural implications of the human XYY genotype. Science 179, 139-150. [\[Medline Link\]](#) [\[Context Link\]](#)
11. Hunter, H. (1977). XYY males: some clinical and psychiatric aspects deriving from a survey of 1811 males in hospitals for the mentally handicapped. British Journal of Psychiatry 131, 464-477. [\[Medline Link\]](#) [\[Context Link\]](#)
12. Jacobs, P. A., Brunton, M. & Melville, M. J. (1965). Aggressive behaviour, mental subnormality and the XYY male. Nature 208, 1351-1352. [\[Medline Link\]](#) [\[Context Link\]](#)
13. Jacobs, P. A., Price, A., Court Brown, W. M., Brittain, R. P. & Whatmore, P. B. (1968). Chromosome studies on men on a maximum security prison. Annals of Human Genetics 31, 339-357.
14. Kolvin, I., Miller, F. J. W., Fleeting, M. & Kolvin, P. A. (1988). Social and parenting factors affecting criminal offence rates. British Journal of Psychiatry 152, 80-90. [\[Medline Link\]](#) [\[Context Link\]](#)
15. Kosten, T. A. & Rounsaville, B. J. (1992). Sensitivity of psychiatric diagnosis based on best estimate procedure. American Journal of Psychiatry 149, 1225-1227. [\[Medline Link\]](#) [\[Context Link\]](#)
16. Lynham, D., Moffitt, T., Stouthamer-Loeber, M. (1993). Explaining the relation between IQ and delinquency: class, race, test motivation, school failure, or self-control? Journal of Abnormal Psychology 102, 187-196. [\[Context Link\]](#)
17. Nielsen, J. & Pelsen, B. (1987). Follow up 20 years later of 34 Klinefelter males with karyotype 47,XXY and 16 hypogonadal males with karyotype 46,XY. Human Genetics 77, 188-192. [\[Medline Link\]](#) [\[Context Link\]](#)
18. Price, W. H. & Whatmore, P. B. (1967). Behaviour disorders and patterns of crime among XYY males identified at a maximum security hospital. British Medical Journal i, 533-536. [\[Context Link\]](#)
19. Ratcliffe, S. G. & Evans, H. J. (1975). Sex chromosome abnormalities and social class. Lancet i, 1144. [\[Context Link\]](#)
20. Nielsen, J., Johnson, S. G. & Sorensen, K. (1980). Follow-up ten years later of 34 Klinefelter males with karyotype 47,XXY and 16 hypogonadal males with karyotype 46,XY. Psychological Medicine 10, 345-352. [\[Medline Link\]](#)

21. Ratcliffe, S. G., Murray, L. & Teague, P. (1986). The Edinburgh study of growth and development of children with sex chromosome abnormalities III. In *Sex Chromosome Aneuploidy: Prospective Studies in Children* (ed. S. G. Ratcliffe and N. Paul). National Foundation March of Dimes. Birth Defects: Original Article Series 22(3): 73-118. [\[Context Link\]](#)
  22. Ratcliffe, S. G., Butler, G. E. & Jones, M. (1991). Edinburgh study of growth and development of children with sex chromosome abnormalities IV. In *Sex Chromosome Aneuploidy: Prospective Studies in Children* (ed. S. G. Ratcliffe and N. Paul). National Foundation March of Dimes. Birth Defects: Original Article Series, 26(4): 1-44. [\[Context Link\]](#)
  23. Ratcliffe, S. G. (1994). The psychological and psychiatric consequences of sex chromosome abnormalities in children based on population studies. In *Basic Approaches to Genetic and Molecularbiological Developmental Psychiatry* (ed. F. Poustka), pp. 99-120. Quintessenz: Berlin. [\[Context Link\]](#)
  24. Sadock, V. A. (1989). Other conditions not attributable to a mental disorder. In *Comprehensive Textbook of Psychiatry*, 5th edn (ed. H. I. Kaplan and B. J. Sadock), p. 1408. Williams & Wilkins: Baltimore. [\[Context Link\]](#)
  25. Schroder, J., De La Chapelle, A., Hakela, P. & Virkkunen, M. (1981). The frequency of XYY and XXY men among criminal offenders. *Acta Psychiatrica Scandinavica* 63, 272-276. [\[Medline Link\]](#)  
[\[Context Link\]](#)
  26. Spitzer, R., Endicott, J. & Robins, E. (1977). *Research Diagnostic Criteria for a Selected Group of Functional Disorders*, 3rd edn. Biometrics Research Division, New York State Psychiatric Institute: New York. [\[Context Link\]](#)
  27. Theilgaard, A. (1984). A psychological study of the personalities of XYY - and XXY - men. *Acta Psychiatrica Scandinavica* 69 (suppl. 315). [\[Context Link\]](#)
  28. Walzer, S. & Gerald, P. S. (1975). Social class and frequency of XYY and XXY. *Science* 190, 1228-1229. [\[Medline Link\]](#) [\[Context Link\]](#)
  29. West, D. J. & Farrington, D. P. (1973). *Who Becomes Delinquent?* Heinemann: London. [\[Context Link\]](#)
  30. Witkin, H. A., Sarnoff, A. M., Schulsinger, F., Bakkestrom, E. & Christiansen, K. D. (1976). Criminality in XYY and XXY men. *Science* 193, 547-555. [\[Medline Link\]](#) [\[Context Link\]](#)
-