ORIGINAL ARTICLE

Violent Crime Perpetrated by Young People

Results of a 13-Year Longitudinal Study of Offenders on Probation

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SUMMARY

Background: The goal of this study was to follow the further legal development of young people who undergo adolescent psychiatric and psychological assessment because of an attempted or actual homicide and are convicted of the crime. We were able to do this over a mean follow-up duration of 12.8 years after conviction through the use of excerpts from the German Federal Central Register (*Bundeszentralregister*).

Methods: There were 114 offenders (103 male, 11 female), whose age at the time of the offense was 17.6 ± 1.9 years (mean, standard deviation). They underwent assessment in an overall period of nearly 31 years after taking the lives of 70 persons. 30 of the offenders (26.3%) had committed the violent crime as part of a group of offenders. We assessed their further course on the basis of data from psychiatric and psychological expert assessments, court judgments, and excerpts from the Federal Central Criminal Register and the Educational File.

Results: 92 (80.7%) of the offenders were German citizens, 12 (10.5%) were from immigrant families, and 22 (19.3%) were foreigners. In 96 cases (84.2%), a psychiatric diagnosis was made at the time of assessment; this was not the case for only 18 individuals (15.8%). 20 (17.5%) were admitted to a psychiatric hospital or drug withdrawal clinic. 44 (38.6%) developed into chronic criminal offenders who continued to commit crimes after the index offense. As a subgroup of the chronic criminal offenders, 13 individuals (11.4% of the overall sample) were identified as multiple intensive offenders; these individuals displayed the most extreme features in every respect. A total of 70 individuals (61.4%) no longer came to the attention of the criminal justice system during the entire duration of follow-up after the index offense. The legal prognosis test was able to predict the offenders' further course with statistical significance, but not accurately enough to be safe.

Discussion: The high rate of mental disorders (84.2%) is noteworthy and in accordance with other, comparable studies. This finding implies that more importance should be attached to psychiatric and psychological diagnosis and treatment. We did not find any limitation of cognitive function in our group of subjects, even though this has been reported in multiple studies in the literature. The intelligence of our subjects was normally distributed.

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According to police crime statistics, which are figures on suspects, in the last 20 years there has been no increase in the number of killings perpetrated by young people in Germany (aged 14 to 20) and a slight drop in crimes resulting in physical injury (1). Figures on convicted individuals also show this trend (2).

Turning to the circumstances that give rise to violent crime (*Figure 1*), there are three groups of factors involved in causing or triggering violence (3):

- Biological or neurobiological risk factors (e.g. male sex, autonomic reactivity abnormalities)
- Psychological and social risk factors (e.g. low intelligence, school failure, unfavorable family relationships, neuropsychological deficits)
- Situational influences (e.g. alcohol and drug use, possession of weapons, group dynamics).

Numerous studies have shown the effect of all three of these groups of factors in causing and triggering violent behavior. However, their contribution is unquantifiable, not least because there are many interactions between them (details in [3] and the *eSupplement*, including *eFigures 1 and 2*, *eBox*).

Manifestation of violent behavior

Figure 1 shows that violent behavior can either follow antisocial behavior and nonviolent crime or occur with no intermediate stages. An example of the latter is a crime of passion: these are almost always the culmination of previous confrontations and not infrequently result in a killing, committed by someone who commits no other crimes before or afterwards (case 70: crime of passion resulting in patricide, *Box 1*).

Young people and adolescents who are charged with murder or attempted murder in Germany almost always undergo adolescent psychiatric and/or psychological examination. However, there is a lack of long-term longitudinal data for this group.

Question investigated

The aim of this study was to follow the legal development of young people who had undergone adolescent psychiatric and psychological examination as a result of committing murder or attempted murder and on whom final sentence had been passed.

Different routes to manifestation of violent behavior (according to [3]: Remschmidt H: Tötungs- und Gewaltdelikte junger Menschen. Ursachen, Begutachtung und Prognose. Heidelberg: Springer 2012 (reproduced with the kind permission of Springer publishers, Heidelberg, Germany))

FIGURE 1

BOX 1

Three example crimes: one crime of passion and two crimes by multiple serious offenders

● **Case 70: Patricide in a crime of passion**

The adolescent, who was 18.7 years old at the time of the offense, killed his father during an escalating confrontation. He was the second child of his parents, who separated when he was 12. At the time of the offense he lived with his father and older brother; his mother had left several years previously. He had left high school after year 9 and had not begun any vocational training. He had obtained drugs. At home there were significant confrontations between him, his older brother, and his father, sometimes violent. The killing was the culmination of a gradually escalating confrontation between the perpetrator and his father when his father threatened to summon the police. The perpetrator took a knife from the kitchen and stabbed his father with it. He removed the bloodstained knife immediately. His father cried out and ran to the telephone to call the police but died at the location of the attack as a result of the stab wound. The perpetrator left the house in the direction of the train station, wandered aimlessly around the town, and the following day attempted suicide in a department store restroom by trying to slash his wrists. He was found there, bleeding heavily.

Examination concluded that the perpetrator suffered from a "schizotypal disorder" (F21 according to ICD-10). The killing was understood as being a typical crime of passion under the additional influence of alcohol and drugs. The court accepted the argument of the expert witness of reduced culpability according to Article 21 of the German penal code and sentenced the perpetrator to five years' imprisonment in a young offenders' institution.

Legal prognosis: the youth committed no other crimes before or after the killing.

● **Case 28: Killing of a homosexual man by an adolescent**

The adolescent, who was 15 years old at the time of the offense, had been sentenced to five years' imprisonment in a young offenders' institution for manslaughter, a particularly serious case of theft, and driving without a license. He had killed a 31-year-old homosexual man by blows to the head with a champagne bottle when the man tried to force him to engage in anal intercourse. Diagnosis according to ICD-10: unsocialized conduct disorder (F91.1).

Legal prognosis: the perpetrator committed multiple subsequent crimes, including bodily harm and false imprisonment.

● **Case 114: Group murder of a pensioner**

The adolescent, who was 20.2 years old at the time of the offense, was sentenced to nine years' imprisonment in a young offenders' institution for murder concurrent with aggravated robbery, attempted murder concurrent with two counts of attempted robbery, and theft. He was ordered to attend a detoxification clinic according to Article 64 of the German penal code. The perpetrator and his accomplices attacked an elderly woman he had met during his civilian national service, in order to obtain drugs. They hit the woman with an iron bar; she died at the location of the attack. The perpetrators stole the woman's purse and also took watches in order to sell them later. After the act they bought a bag of heroin and wanted to give themselves "the golden shot" (a lethal injection of heroin). However, this was unsuccessful. ICD-10 diagnosis of main perpetrator: dependence syndrome (F19.2) due to multiple substance use.

Legal prognosis: the main perpetrator already had multiple entries in the central register before the index act. He has a further 17 central register entries after the index act, including for threatening behavior, slander, and grievous bodily harm.

Methods

Study and sample design

The study design is shown in *Figure 2*. The starting point was the index act, the reason a particular individual underwent assessment. The expert assessment was explained or supplemented during trial and in most cases made a major contribution to the verdict found. After they were sentenced to imprisonment or found not to be criminally culpable or to be culpable to only a limited extent, and admitted to a psychiatric hospital according to Article 63 of the German penal code or a detoxification clinic according to Article 64 of the German penal code, the perpetrators' subsequent legal development was followed using extracts from Germany's Federal Central Criminal Register for an average of 154 months (approximately 12.8 years). This allowed us to identify the offender type groups shown in *Figure 2*, based on crimes committed before and after the index act. However, these could only be identified retrospectively, after extracts from the Federal Central Criminal Register had been obtained.

Figure 2 shows that a mean of 8 ± 7.3 months elapsed between the index act and examination, and that the mean time from examination to trial was also more than six months (6.1 ± 7.5).

This study includes only medical certificates of individuals who had been sent by court order to the Department of Child and Adolescent Psychiatry and Psychotherapy at Philipps University, Marburg for examination after committing serious violent crime between 1976 and 2007. It includes a total of 114 perpetrators, 103 male and 11 female, aged 17.6 ± 1.9 years (range: 14 to 21 years). The youngest perpetrators were nine 14-year-olds. All individuals were examined by two experienced child and adolescent psychiatrists (H.R. and M.M.). The psychological examinations

carried out as part of medical certification were performed by an experienced clinical psychologist and psychotherapist (G.N.).

Psychiatric diagnoses were made according to the Multiaxial Classification Scheme for Child and Adolescent Psychiatric Disorders (MAS) (Remschmidt et al., 2012 [4] or earlier versions; see also: World Health Organization (ed.): Multiaxial classification of child and adolescent psychiatric disorders. World Health Organization, Cambridge: Cambridge University Press 1996), using the ICD-10 research criteria (5). As ICD-10 was not published until 1991, diagnoses made according to ICD-9 before that date were re-coded according to ICD-10. As shown in *Table 1*, the most common crime was murder, which accounted for 36.8% of cases, followed by manslaughter at 11.4%.

The examination methods and statistical tests used are shown in *Box 2*.

Results

Total sample

Table 2 provides an overview of the sociodemographic data of the 114 perpetrators. *Table 3* provides an overview of the psychiatric diagnoses of the sample as a whole. Strikingly, only 18 perpetrators (15.8%) failed to meet the criteria for a psychiatric diagnosis according to ICD-10.

Crime-based and perpetrator-based subsamples

Extracts from the Federal Central Criminal Register or Educational File were used to identify offender type retrospectively and to follow perpetrators' legal development prospectively (see *Figure 2*). Even individuals with only one entry in the register (group A, $n = 34$) committed serious crimes. Of these, 21 (62%) led to the death of the victim, usually as a result of murder. The

TABLE 1

Crimes committed by 114 perpetrators (103 male, 11 female)

Crime	Frequency in total sample		Female perpetrators only	
	n	%	n	%
Murder	42	36.8	2	18.1
Attempted murder	12	10.5	1	9.1
Manslaughter	13	11.4	2	18.2
Attempted manslaughter	14	12.3	1	9.1
Bodily harm resulting in death	5	4.4	1	9.1
Grievous bodily harm	20	17.5	2	18.2
Robbery resulting in death	2	1.8	–	–
Physical injury	6	5.3	2	18.2
	114	100.0	11	100.0

perpetrators in this group who had committed murder included two 14-year-olds. Despite the seriousness of their crimes, individuals with only one entry (group A) were rated as less abnormal according to the Marburg Symptom Rating than those with multiple entries

(groups B and C). The differences concerned symptoms of antisocial behavior, aggression, poor performance, and symptoms of hyperactivity.

There were no differences between the Marburg Symptom Rating scores of the desisters in the sample (group B) and those of the persisters (group C) except for symptoms of anxiety, which were rated significantly lower in group C. There were no significant differences in intelligence between the three groups.

Table 4 compares the Marburg Symptom Rating scores of the three offender type groups. It is important to bear in mind that the Marburg Symptom Rating scores were obtained during medical certification, i.e. an average of 12.8 years before the offender type groups were identified. Within the group of persisters was a subgroup of multiple intensive offenders ($n = 13$). Members of this subgroup committed more than 30 crimes and/or had more than 10 entries in the central register, regardless of when these events occurred. This definition is supported by similar procedures in the literature; as yet there is no universally accepted definition of this subgroup (9).

Multiple intensive offenders were the most abnormal subgroup in many different respects: nine of the 13 individuals had committed a killing, including six acts of murder. They differed significantly from offenders with one register entry in terms of their overall Marburg

BOX 2

Examination methods and statistical procedures used

- Standardized history taken from perpetrators and their parents or role models: reason for examination, family history, perpetrator's history, current situation, physical safety issues
- Youth psychiatric examination and diagnosis according to the Multiaxial Classification Scheme for Child and Adolescent Psychiatric Disorders (MAS) (Remschmidt et al., 2012 [4] or earlier versions; see also: World Health Organization (ed.): Multiaxial classification of child and adolescent psychiatric disorders. World Health Organization, Cambridge: Cambridge University Press 1996) using ICD-10 assessment criteria (5); diagnoses made according to ICD-9 before 1991 re-coded according to ICD-10
- Examination concerning the act, the environment in which it was committed, the motivation for it, and the relationship between perpetrator and victim: history of the act, detailed description of what occurred and why, subsequent behavior, perpetrator's opinion regarding the act
- Psychological examination involving various tests: intelligence tests (Wechsler scales, CPM, CFT 20), performance tests, and personality tests (FPI, MMPI, HSPQ) in all cases; other, special procedures where indicated
- Standardized basic documentation from the Department of Child and Adolescent Psychiatry and Psychotherapy at Philipps University Marburg: demographic data, symptoms, neurological findings, diagnoses according to MAS, proposed measures
- Use of a draft version of the Marburg Symptom Rating (an applicable, validated tool to determine psychopathological abnormalities) (6)
- Family adversity index according to (7), which can be used to find a total score based on several sociodemographic and clinical factors
- Legal prognosis test from (8) to estimate future prognosis
- Structured evaluation of the sentences received by all the perpetrators: time-related factors (e.g. time from crime to trial, agreement between medical certification and sentence, type and severity of sentence, any therapeutic interventions, if any)
- Analysis of Federal Central Criminal Register data and Educational Files, available for all the perpetrators until 2 February 2009
- Statistical procedures: in addition to descriptive parameters (mean and standard deviation for numerical variables, percentages for nominal scalar variables), the following statistical procedures were used: the chi-square test was used to compare two groups in terms of a binary variables such as the presence of a symptom; *t*-tests were used to compare the mean of numerical variables such as IQ and age; ROC curves were used to investigate the prognostic value of the LDJ (eSupplement). Kaplan–Meier curves were drawn and the log-rank test used to predict relapses.

CPM, Coloured Progressive Matrices (non-verbal intelligence test); CFT, Culture Fair Test (intelligence test); FPI, Freiburg Personality Inventory; MMPI, Minnesota Multiphasic Personality Inventory; HSPQ, High School Personality Questionnaire; LDJ, Legal Prognosis Test for Dissocial Youth (Legalprognosestest für Dissoziale Jugendliche)

Symptom Rating scores (ANOVA) (group A, *t*-test, $p < 0.03$) and overall Legal Prognosis Test (LDJ, Legal Prognosis Test for Dissocial Youth) scores (group A, *t*-test, $p < 0.001$); there was a trend when compared to desisters (group B, *t*-test, $p = 0.06$). The difference was always greater abnormality in multiple serious offenders. Two examples are described in *Box 1* (case 28: killing of a homosexual man by a youth; case 114: group murder of a pensioner).

The only other perpetrator-based subgroup to be mentioned here is that of perpetrators who acted together with others ($n = 30$). Group dynamics led to a higher killing rate in this subgroup than among perpetrators who acted alone. Group dynamics are very significant in leading to crime among individuals of the ages analyzed in this article.

A prototypical example of this occurred in 2002, when three US school students (aged 15, 17, and 18) threw stones at an approaching vehicle in the darkness of a highway bridge, resulting in the deaths of two women. The three perpetrators, who were psychologically normal, intelligent, and fully culpable, had largely blotted out the dangerous nature of their behavior as part of an increasing group dynamic process involving “tests of courage.” Ultimately, like their parents and the general public (the case was widely reported in the press), they were shocked by what they had done. They were sentenced to imprisonment for 7 years, 8 years, and 8½ years in a young offenders’ institution for two counts of murder and were released after serving two-thirds of that time in the USA. It is not known whether they have committed any further crimes.

Of the total sample of perpetrators, 20 (17.5%) were admitted to a psychiatric hospital or detoxification clinic ($n = 3.5\%$) for their disorders. Thirty-seven perpetrators (32.5%) committed their violent acts under significant influence of alcohol and/or drugs. In 22 cases (19.3%) the victim was a relative; 14 of these resulted in the relative’s death, including one case of the killing of both parents and the sister of the perpetrator, and one case of the killing of both parents by a contract killer.

The mean number of crimes committed was 10.5 ± 12.6 , with a maximum of 72. The mean number of entries in Germany’s central register was 4.3 ± 4.2 , with a maximum of 22.

The intelligence of the total sample (mean IQ: 101 ± 17) was normally distributed; IQ scores ranged from 50 to 143; five perpetrators (4.4%) had an IQ of between 50 and 69, and six (5.3%) of more than 130.

Longitudinal results and prognosis

As already described and shown in *Figure 2*, 44 (38.6%) of the perpetrators committed subsequent crimes, becoming persisters, during the observation period; this lasted 12.8 years following their index act. Half the perpetrators committed further violent crime, and half a number of other crimes, especially damage to property, traffic offenses, and breaches of controlled substances legislation. The violent reoffending rate was

TABLE 2

Sociodemographic details of 114 perpetrators

Nationality	Frequency	
	n	%
German	80	70.2
German with background of migration	12	10.5
Foreign	22	19.3
Total	114	100

Social class according to profession of family breadwinner	Frequency	
	n	%
Unskilled manual labor	25	21.9
Skilled manual labor, technician	57	50.0
White-collar, executive, freelance, self-employed with small enterprise	16	14.0
Self-employed with large enterprise, university graduate	5	4.4
Unknown	11	9.7
Total	114	100.0

Parents’/role models’ relationship	Frequency	
	n	%
Live together	55	48.2
Separated/divorced or dead	49	43.0
Never lived together	5	4.4
Unknown	5	4.4
Total	114	100.0

Schooling of 114 perpetrators	Frequency	
	n	%
Did not graduate from school (compulsory education only)	36	31.6
General secondary school (“Hauptschule”)	39	34.2
Intermediate secondary school (“Realschule”)	6	5.3
General qualification for university entrance (“Abitur”)	4	3.5
Not yet completed (if still eligible for compulsory education or attending school)	25	21.9
Unknown	4	3.5
Total	114	100.0

19.3%. None of the persisters committed a further killing.

The legal prognosis test for antisocial young people (LDJ) developed by Hartmann and Eberhard (8) was used at the time of examination to assess reoffending over time. This test includes 11 items. It was published in 1972 and was used to provide uniformity between examination tools, since this study covered examinations made over a period of 31 years and newer prognosis tools were not available until the 1990s. ROC analyses showed that the LDJ does make a contribution to predict violent reoffending, although only a small one. Details are provided in the *eSupplement*.

TABLE 3

ICD-10 psychiatric diagnoses of 114 perpetrators (103 male, 11 female)

	Frequency	
	n	%
None	18	15.8
Mental and behavioral disorders due to psychoactive substance use (F1) [F10-F19]	6	5.3
Schizophrenia, schizotypal, and delusional disorders (F2) [F20-F29]	8	7.0
Mood [affective] disorders (F3) [F30-F39]	1	0.9
Neurotic, stress-related and somatoform disorders (F4) [F40-F48]	1	0.9
Disorders of adult personality and behaviour (F6) [F60-F69]	47	41.2
Hyperkinetic disorders (F90)	2	1.8
Conduct disorders (F91)	31	27.2
Total	114	100.0

Discussion

The sociodemographic data of the sample is typical for young adult and adolescent perpetrators. However, there was no major overrepresentation of lower social classes. The correlation between mildly reduced intelligence and crime, which has been described many times in the literature, could not be confirmed (10, 11); the correlation had been found even for unrecorded crime (hidden figures) (12). IQ was normally distributed in this sample.

Subsequent criminal behavior was recorded for 44 (38.6%) of persisters; half of these cases involved violent crime, and half nonviolent crime. These results correspond almost exactly to those of a similar sample

analyzed by Günter et al. (13, 14), who after a longer follow-up period found reoffending rates of 38% for all crimes and 20% for violent crime. The other 70 perpetrators did not commit any further crimes during the observation period, according to the central register.

In the study of crime committed by children, in which a representative sample ($n = 210$) of children too young to be charged was followed for a period of approximately 30 years, there were 68 persisters (32.4%). The number of perpetrators of violent crime in the total sample was 33 (15.7%); the number among the persister subgroup was 24 (35.3%) (15, 16).

The high proportion of perpetrators with psychiatric diagnoses found in our sample is in line with comparable studies that found psychiatric diagnoses in 90% of prisoners in young offenders' institutions (17, 18).

Limitations

Although the sample of perpetrators used in this study may be considered unrepresentative (in any case no such representative sample exists), a sample of this size can be assumed to contain the most common constellations of criminal acts for the age group addressed here. This means that to a certain extent the results for the sample can be generalized. One point of criticism may be that some tests (e.g. IQ tests) were revised during the long study period. Even psychiatric diagnoses have changed, namely when ICD-9 was replaced by ICD-10 in 1991. This gave rise to the need to recode ICD-9 diagnoses as ICD-10 diagnoses. In addition, register data naturally cannot provide any information on undetected crimes. These limitations must be accepted. However, we believe that the underlying conclusions drawn from the study are not affected by this. Against criticism of the methods used, there are a number of

TABLE 4

Comparison of psychological abnormalities (according to the Marburg Symptom Rating) of the three crime burden groups

Fisher's exact test, $df = 2$ (two-tailed), total sample ($n = 112$)					
	Group A: one register entry $n = 33^*$ (29.5%)	Group B: desisters $n = 35^*$ (31.3%)	Group C: persisters $n = 44$ (39.3%)	Total	Chi-square
Antisocial behavior	20 (60.6%)	32 (91.4%)	39 (88.6%)	91 (81.3%)	$p = 0.002$
Aggression	25 (75.8%)	33 (94.3%)	43 (97.7%)	101 (90.2%)	$p = 0.005$
Anxiety	14 (42.4%)	17 (48.6%)	10 (22.7%)	41 (36.6%)	$p = 0.042$
Underperformance	11 (33.3%)	30 (85.7%)	36 (81.8%)	77 (68.8%)	$p = 0.000$
Hyperactivity	1 (3.0%)	6 (17.1%)	14 (31.8%)	21 (18.8%)	$p = 0.004$
Post hoc comparisons					
Antisocial behavior	A-B: $p = 0.004$		A-C: $p = 0.006$	B-C: $p = 1$	
Aggression	A-B: $p = 0.042$		A-C: $p = 0.004$	B-C: $p = 0.581$	
Anxiety	A-B: $p = 0.635$		A-C: $p = 0.084$	B-C: $p = 0.019$	
Underperformance	A-B: $p = 0.0005$		A-C: $p = 0.0005$	B-C: $p = 0.764$	
Hyperactivity	A-B: $p = 0.107$		A-C: $p = 0.001$	B-C: $p = 0.194$	

* For one individual the Marburg Symptom Rating was unavailable

KEY MESSAGES

- In the last 20 years there has been no increase in the number of killings perpetrated by young people (adolescents and young adults) and a slight drop in crimes resulting in physical injury.
- Biological, psychological, and situational factors all play a role in causing violent crime.
- Longitudinal studies on legal development have shown that the majority of those who commit violent crime do not commit any further crimes after the index act, but that 38.6% become persisters. This includes a hard core of multiple serious offenders (11.4% in this study), who represent a not inconsiderable danger.

advantageous factors: personal knowledge of all perpetrators, and in most cases also of their parents or role models; and the use of the same examination methods throughout the study period.

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Conflict of interest statement

Prof. Remschmidt received fees for providing expert forensic opinions for the courts.

PD Dr. Martin received fees for providing expert forensic opinions for the courts.

Dr. Niebergall received fees for providing expert forensic certification for the courts.

Dr. Heinzel-Gutenbrunner declares that no conflict of interest exists.

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For eReferences please refer to:
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eSupplement, eFigures, eBoxes:
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eSUPPLEMENT

Violent Crime Perpetrated by Young People

Results of a 13-Year Longitudinal Study of Offenders on Probation

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The Legal Prognosis Test developed by Eberhard and Hartmann (LDJ, *Legalprognosetest für Dissoziale Jugendliche*, 1972) contains 11 items that are easy for someone who knows the perpetrator to assess. These are as follows:

- Attendance at a school for children with learning disabilities (special school)
- Running away from home
- Frequent change of employment
- Alcohol abuse
- Tattoos
- Bad company
- Aggression towards persons or objects
- Prosecution for traffic offenses
- Prosecution for other offenses
- No prosecution but recorded as having committed crime
- More than 3 acts of criminal offense.

The item “Tattoos” would today no longer be treated as a predictive factor. In the 1970s, however, it was clearly of value.

ROC analyses showed that the LDJ does make a contribution to predicting slightly violent reoffending. The area under the curve (AUC) was 0.755 ($p = 0.002$), and thus its discriminatory value was acceptable.

Kaplan–Meier curves and the log-rank test showed that the perpetrators with a low burden according to the LDJ reoffended later than those with a high burden. This was especially true of total reoffending ($p = 0.016$), slightly violent reoffending ($p = 0.045$), and violent reoffending ($p = 0.004$).

The first step in investigating the LDJ’s potential to predict reoffending was to perform ROC analyses. Reoffending was divided into four categories:

- Total reoffending (any subsequent crime)
- Nonviolent reoffending
- Slightly violent reoffending (bodily harm, willful bodily harm, negligent bodily harm)
- Seriously violent reoffending (actual and attempted grievous bodily harm, aggravated bodily harm, robbery, unlawful detention, manslaughter, and murder).

An ROC curve is drawn by plotting a graph of percent sensitivity against 100 minus specificity showing every possible cut-off point, and drawing a curve through the points plotted.

The larger the area under this curve, the better the evidence that the LDJ can be used to predict reoffending. The best possible value is 1. An AUC of 0.5, in contrast, means that the LDJ does not contribute to predicting reoffending.

The ROC curve for slightly violent reoffending is shown in *eFigure 1*.

The following results were obtained:

- AUC for total reoffending: 0.656 ($p = 0.005$)
- AUC for slightly violent reoffending: 0.755 ($p = 0.002$)
- AUC for seriously violent reoffending: 0.642 ($p = 0.057$)
- AUC for nonviolent reoffending: 0.666 ($p = 0.005$).

Hosmer and Lemeshow (2000) (e1) provide a rule of thumb for interpreting AUC values:

AUC = 0.5: no discrimination; $0.7 \leq \text{AUC} < 0.8$: acceptable discrimination; $0.8 \leq \text{AUC} < 0.9$: excellent discrimination; $\text{AUC} \geq 0.9$: outstanding discrimination.

ROC curve: LDJ as predictor of slightly violent reoffending. LDJ: Legal Prognosis Test

According to this, acceptable discrimination is achieved only for slightly violent reoffending.

Next, event data analysis was used to investigate whether perpetrators with high scores reoffended sooner than those with low scores; see (e2).

The perpetrators were then divided into two groups by LDJ score: those with a low burden (scores 1 to 4; $n = 78$) and those with a high burden (scores 5 to 11; $n = 36$). As we had access to data on reoffending by the perpetrators in the study until 2 February 2009, Kaplan–Meier curves could be plotted for prognosis of reoffending. Here too, the four categories of reoffending listed above were used.

Kaplan–Meier curves provide a descriptive comparison of time to reoffending in the two groups of perpetrators. *eFigure 2* shows both Kaplan–Meier curves for total reoffending. It is clear that perpetrators with high scores reoffended sooner than those with low scores, and that the percentage of non-reoffenders decreased more rapidly (*eFigure 2*). Although Kaplan–Meier curves provide only a visual representation, an appropriate significance test, the log-rank test, can assess whether the differences between the groups become significant. This compares not the probability of reoffending overall, but rather the curves throughout the observation period.

The log-rank test revealed the following p -values:

- Total reoffending: $p = 0.016$
- Slightly violent reoffending: $p = 0.045$
- Seriously violent reoffending: $p = 0.226$
- Nonviolent reoffending: $p = 0.004$

eFIGURE 2

Continued absence of reoffending

Time to reoffending: next offense of perpetrators with burdens rated high and low according to the LDJ (Legal Prognosis Test)

ORIGINAL ARTICLE

Violent Crime Perpetrated by Young People

Results of a 13-Year Longitudinal Study of Offenders on Probation

Helmut Remschmidt, Matthias Martin, Gerhard Niebergall, Monika Heinzl-Gutenbrunner

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eBOX

Causes of violence

1. Neurobiological risk factors and explanations for violent behavior

- Male sex, age
- Congenital abnormalities in autonomous reactions
- Prenatal and perinatal risk factors
- Mild physical abnormalities
- Neuroendocrinological abnormalities
- Maturation-related risk factors
- Structural and functional brain disorders
- Psychological and developmental disorders
- Genetic factors

2. Psychosocial and social influences and explanations for violent behavior

- Reduced intelligence
- School failure, dropping out of school
- Specific disorders of psychological development
- Moral/ethical developmental deficits
- Neuropsychological abnormalities
- Psychological disorders
- Personality traits
- Unfavorable familial influences
- Unfavorable surroundings
- Influence of media

3. Situational influences on the manifestation of violent behavior

- Emotionally charged and provocative situations
- Alcohol and drug use
- Access to weapons, possession of weapons (knife, bat, firearm)
- Peer pressure and group dynamics
- Opportunity
- Ideological and political outlook of those prepared to use violence

The literature states that all the influencing factors detailed in this box are involved in causing or triggering violent behavior. However, due to highly varied interactions between them, the contribution of individual factors cannot be quantified. This is presented in detail in (2)