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Birth Complications Combined With Early Maternal Rejection at Age 1 Year Predispose to Violent Crime at Age 18 Years

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**Background:** This study tests the biosocial interaction hypothesis that birth complications when combined with early maternal rejection of the infant predispose to adult violent crime.

**Methods:** This hypothesis was tested using a cohort of 4269 consecutive live male births on whom measures of birth complications (age 0), early maternal rejection (age 1 year), and violent crime (age 18 years) were collected.

**Results:** A significant interaction ($P<.0001$) between birth complications and early maternal rejection indicated that those who suffered both birth complications and early child rejection were most likely to become violent offenders in adulthood. While only 4.5% of the subjects had both risk factors, this small group accounted for 18% of all violent crimes. The effect was specific to violence and was not observed for nonviolent criminal offending.

**Conclusions:** To our knowledge, this is the first study to show that birth complications in combination with early child rejection predispose to violent crime. The findings illustrate the critical importance of integrating biological with social measures to fully understand how violence develops and also suggest that prenatal, perinatal, and early postnatal health care interventions could significantly reduce violence.

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The recent report on understanding and preventing violence from the National Research Council suggests that birth complications may predispose to violence, but empirical support for this link is currently very limited. While several studies have indicated that perinatal factors are linked to later antisocial and criminal behavior, not all studies have confirmed this relationship.

There are four limitations to these important but initial studies that may help explain conflicting findings. First, samples tend not to have been representative of the general population. Second, it is unclear whether the effect is specific to violence or can be observed for nonviolent crime or repeated criminal offending; most previous research has found it difficult to isolate specific correlates of violent crime as opposed to correlates of criminal behavior in general. Third, and most important, previous studies have not considered the possibility that birth complications may additionally require a negative early psychosocial environment to result in the specific outcome of violent behavior in adulthood. Research on school performance, for example, has indicated that the combination of birth complications and a negative family environment is associated with poor school performance. While the interaction between biological and environmental variables is commonly believed to be important in explaining violent behavior, there is surprisingly little hard empirical evidence to support such a view. Fourth, previous studies have not assessed the potential importance of early child rejection in predisposing to violence. Maternal rejection of the infant and disruption to the mother-infant bond, in conjunction with a biological predisposition to violence, could prove critical in disrupting interpersonal development and predis-
METHODS

SUBJECTS

Male subjects (N=4269) were drawn from a total cohort of 9125 consecutive births of males and females that took place in the maternity department of the State University Hospital (Rigshospitalet) in Copenhagen, Denmark, between September 1959 and December 1961. All live deliveries of over 20 weeks' gestation were included. Informed consent for human investigation was obtained from the parents. Further details of the birth cohort used in this study have been reported elsewhere. Only data from males were analyzed because the very low rates of criminal violence in females (0.3%) precluded meaningful statistical analyses.

BIRTH COMPLICATIONS

Birth complications and conditions were recorded at the time of delivery by an obstetrician assisted by a midwife. This study uses a frequency birth complications score developed through the collaboration of American and Danish obstetricians and pediatric neurologists. Examples of delivery complications on this scale include forceps extraction, breech delivery, umbilical cord prolapse, preeclampsia, and long birth duration. For analysis purposes, the subjects were divided into two groups: those with no delivery complications and those with one or more complications.

EARLY CHILD REJECTION AND SOCIAL CIRCUMSTANCE MEASURES

Demographic, family, and psychosocial variables were collected during pregnancy and when the child was 1 year old. Variables collected during pregnancy relevant to our analyses include whether the pregnancy was wanted or unwanted, the mother's attempts to abort the fetus, and the mother's age. Year 1 follow-up interview variables included home conditions, marital status, and placement of infant for care into a full-time public institution for more than 4 months of the first year. The socioeconomic status of the family (based on educational and occupational levels) was obtained at 1 year from the Danish Central Persons Register.

A factor analysis using principal component analysis followed by a varimax rotation produced two factors with eigenvalues greater than 1. The two factors were defined as follows (factor loadings in parentheses): factor 1, "poor social circumstances": unmarried mother (.71); low socioeconomic status (.67); poor home conditions (.65); young maternal age (.64); unwanted pregnancy (.59); and factor 2, "early child rejection": public institutional care of infant (.68); attempt to abort fetus (.63); unwanted pregnancy (.44).

Having an unwanted pregnancy was the only measure common to both factors, but this variable was associated with two different psychosocial patterns. In factor 2, this lack of planning was coupled with a more "rejecting" pattern of behavior as indicated by the fact that the mother had attempted to abort her pregnancy, followed after birth by the child being sent to an institution for at least 4 months in the first year. Conversely, in factor 1, the unwanted pregnancy was not linked to these variables but instead was linked to poor family and social circumstances, including low social class, paternal absence, poor home conditions, and young maternal age. Consequently, factor 1 was tentatively labeled "poor social circumstances" while factor 2 was labeled "early child rejection."

Data were complete on all variables in this study with the exception that socioeconomic status information was missing for 653 subjects. In the results reported below, the data were analyzed in two ways: (1) using the reduced sample of 3616 and (2) using the entire sample of 4269. In analyses of the entire sample, the early maternal rejection factor was recomputed with the loading of social class (which did not load significantly on this factor) omitted.

VIOLENT CRIMINAL OFFENDING

Criminal status was assessed when the offspring were aged 17 to 19 years by a search of the Danish National Criminal Register in which all police contacts and court decisions involving Danish citizens are recorded. This is viewed as one of the most comprehensive and accurate registers in the Western world. The definition of violence used by the National Academy of Sciences Panel on the Understanding and Control of Violence ("behaviors by individuals that intentionally threaten, attempt, or inflict physical harm on others") was used. Consequently, violent crime was defined by the following offenses: murder, attempted murder, assault (including domestic assault), rape, armed robbery, illegal possession of a weapon, and threats of violence. Nonviolent crime was defined as theft, breaking and entering, fraud, forgery, blackmail, embezzlement, vandalism, prostitution, pimping, and narcotic offenses. One hundred forty-five subjects were classified as violent criminals (3.4%), 540 as nonviolent criminals (12.6%), and 3584 as noncriminals (84.0%). The total criminality rate of 16% in this Danish sample is similar to the rate of 17% found by Raine et al for a community sample of English males.

posing to more callous, violent interpersonal behavior in later life.

The study reported herein attempts to overcome some problems associated with previous studies to better test the biosocial interaction hypothesis that birth complications interact with negative early psychosocial environment in predisposing to adult violent offending. In particular, the possibility that early child rejection may be a specific and important aspect of a negative psychosocial environment in predisposing to violence was tested. Specificity to violent as opposed to nonviolent crime was also assessed.

RESULTS

VIOLENT OFFENDERS VS NONCRIMINALS

A logistic regression analysis indicated a highly significant interaction between delivery complications and early child rejection in predicting violence ($\chi^2 [df=1$, $N=3175]=10.4, P<.002$) and indicated that those who experienced both birth complications and early child rejection were most likely to become violent. To exemplify this relationship diagrammatically, rates of
POTENTIAL CONFOUNDERS

Reduced Sample Size Due to Missing Data

The effect of the interaction of birth complications and early maternal rejection was reanalyzed for the total sample of 4269 by recomputing scores on the early maternal rejection factor as described above. The interaction between birth complications and early child rejection was again significant when comparing violent criminals with noncriminals ($\chi^2 [df=1, N=3729]=12.3, P<.0005$) and when comparing violent criminals with nonviolent criminals ($\chi^2 [df=1, N=685]=7.2, P<.007$).

Controlling for Recidivism

The interaction between birth complications and early child rejection in predisposing to violence cannot be accounted for by the fact that violent offenders commit more crime in general than nonviolent criminals. When violent offenders were compared with nonviolent offenders, the interaction between birth complications and early child rejection in predisposing to violent crime remained significant and in the predicted direction when the total number of crimes was entered as a covariate ($\chi^2 [df=1, N=557]=6.56, P<.01$). Furthermore, when violent offenders were matched on total number of crimes committed with an equal number of nonviolent offenders, the interaction remained significant and in the predicted direction ($\chi^2 [df=1, N=332]=4.2, P<.05$). These results indicate that the biosocial interaction applies to all violent offenders whether they commit repeated offenses or not.

COMMENT

To our knowledge, this is the first study to provide evidence from a large birth cohort to show that birth complications in combination with a negative psychosocial environment (specifically early child rejection) are associated with violent crime in early adulthood. In contrast, the very few previous biosocial studies have neither shown specificity for violence nor highlighted the specific importance of early child rejection. The interaction between biological and social predispositions appears to be critically important in understanding violent offending because possession of only one risk factor (ie, birth complications alone or early child rejection alone) was not associated with increased rates of violence. This interaction effect was found to be specific to violent crime and not crime in general, whereas most previous biological research has not obtained specificity for violent crime per se.

The fact that birth complications combined with child rejection but not the more general factor of poor social circumstances in predisposing to violence helps establish a more specific biosocial pathway toward violent crime. Poor social circumstances such as low social class and poor home conditions have been found to be general, weak correlates of violent and nonviolent crime, whereas there is some evidence that variables related to child rejection such as child neglect, lack of maternal warmth, and separation from parents may be more spe-
cific predispositions toward violent crime in particular.19-21 Disruption to the mother-infant bonding processes due to institutionalization has been associated with affectionless psychopathic criminal behavior.22,23 Poor early bonding may therefore lead to more callous, affectionless, unempathic interpersonal relationships that in turn may increase the likelihood of violent interpersonal behavior, particularly when combined with a preexisting biological predisposition to violence.

It is not known precisely how birth complications predispose to violence, but it is possible that such complications result in brain dysfunction and associated neurological and neuropsychological deficits that in turn directly and indirectly predispose to violence.24-26 For example, birth complications could lead to cognitive deficits that in turn lead to school failure, occupational failure, and ultimately violence. Similarly, birth complications may contribute to neuropsychiatric deficits and lack of self-control, resulting in explosive, impulsive aggression.7 The effects of any such brain dysfunction may in turn be exacerbated by a negative early psychosocial environment.8,9

While prospective longitudinal studies can help tease out causality by establishing temporal ordering of variables, they cannot establish causality per se, and several causal pathways are feasible other than the one described above. Specifically, it is possible that a third factor underlies the link between birth complications/parental rejection and violence. For example, it is conceivable that there are genetic predispositions to birth complications, negative parenting, and violence and that genetic factors underlie the observed relationships.

It could be argued that birth complications and maternal rejection are not independent events. Specifically, children with birth complications might be more likely to be rejected by their mothers. This scenario seems unlikely, however, for two reasons. First, two of the three variables making up the construct of early child rejection precede birth in time (unwanted pregnancy, attempts to abort fetus) rather than postdating birth complications. Second, birth complications and early child rejection were not positively correlated in this sample (r = -0.029), indicating that these constructs reflect processes that are largely independent.

We would caution against the overgeneralization of our findings to other populations at this stage and emphasize the need for replication of our findings in the United States. Denmark is a relatively homogeneous society and future studies are needed to confirm this biosocial interaction in countries such as the United States with its higher rates of violent crime. Such homogeneity in Denmark may, however, reduce the amount of variance in violence and attenuate our findings; as such, it is anticipated that similar findings to those observed in Denmark might be expected in a future replication study in the United States. We also would caution that these findings do not demonstrate causal links between birth complications/early child rejection and later violence, although the prospective, longitudinal nature of the study helps to provide some support for such an interpretation. Furthermore, it is recognized that birth complications and early child rejection are only two of many risk factors for violence, which also include learning deficits,27 parental criminality,28 low serotonin levels,29 parental absence,30-32 neuropsychological deficits,19-21,23,32 poor parental supervision,33,34 child abuse,20,32 low arousal,16 poor affective relationships,35,36 and parental criminality.37

Results of this study raise two important questions with respect to efforts to reduce rates of violence that focus on biological and psychosocial risk factors. The first question concerns whether interventions aimed at providing better antenatal health care to underserved populations could have an effect in reducing rates of violence. The recent National Research Council report on understanding and preventing violence recommended that serious consideration be given to conducting such interventions to reduce perinatal complications, although this recommendation was based on limited empirical data. In the present study, we found that although only 4.5% of population had both birth complications and early child rejection, this small group accounted for 18% of all violent crimes perpetrated by the entire sample of 4269. Assuming early interventions could successfully reduce birth complications and the link between birth complications and violence is causal, these findings suggest that such interventions could conceivably reduce violence in the next generation by as much as 18%. The current findings lend some support for the consideration of initial perinatal intervention research studies to test whether the link between birth complications/early child rejection and violence is causal.

The second question concerns whether changing the psychosocial environment can help reduce violence in society. Very little is known regarding what factors protect a biologically predisposed individual from becoming violent. The finding that birth complications do not predispose to violence when combined with a nonrejecting early home environment (Figure) is of potential importance because it suggests that a good psychosocial home environment can protect against the otherwise negative effects of birth complications. This is consistent with previous findings that good parental care and the opportunity to bond with a caregiver in the first year of life can reduce the deleterious cognitive and behavioral effects of birth complications.20 Psychosocial interventions aimed at increasing caregiving skills to parents may conceivably help suppress this biological predisposition to later adult violence.

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