

Behavioral Risk Assessment From Newborn to Preschool: The Value of Older Siblings

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abstract

OBJECTIVES: The aim of this study was to examine the plausibility of a risk prediction tool in infancy for school-entry emotional and behavioral problems. Familial aggregation has been operationalized previously as maternal psychopathology. The hypothesis was tested that older sibling (OS) psychopathology, as an indicator of familial aggregation, would enable a fair level of risk prediction compared with previous research, when combined with traditional risk factors.

METHODS: By using a longitudinal design, data on child and family risk factors were collected on 323 infants ($M = 2.00$ months), all of whom had OSs. Infants were followed up 4.5 years later when both parents provided ratings of emotional and behavioral problems. Multiple regression and receiver operating characteristic curve analyses were conducted for emotional, conduct, and attention problems separately.

RESULTS: The emotional and behavioral problems of OSs at infancy were the strongest predictors of the same problems in target children 4.5 years later. Other risk factors, including maternal depression and socioeconomic status provided extra, but weak, significant prediction. The area under the receiver operating characteristic curve for emotional and conduct problems yielded a fair prediction.

CONCLUSIONS: This study is the first to offer a fair degree of prediction from risk factors at birth to school-entry emotional and behavioral problems. This degree of prediction was achieved with the inclusion of the emotional and behavioral problems of OSs (thus limiting generalizability to children with OSs). The inclusion of OS psychopathology raises risk prediction to a fair level.

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WHAT'S KNOWN ON THIS SUBJECT: Risk prediction during infancy for school-entry child psychopathology has not been previously possible. Although individual risk factors have been identified, their cumulative predictive power has been too low for effective screening.

WHAT THIS STUDY ADDS: By including a measure of older sibling psychopathology and combining this with previously identified child and family risk factors in a prediction analysis, prediction to school-entry psychopathology among children with older siblings reaches a fair level.

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Mental health problems in adolescence and adulthood often originate in the childhood period and manifest as emotional and behavioral problems.¹ Such problems may be reliably identified in children as young as 18 months old.² Externalizing problems include noncompliance, aggression, impulsivity, destructiveness, impaired attention, etc, and show stability over the life course.^{3,4} Internalizing problems are characterized by anxiety and depressive symptoms⁵ and are also stable over time.^{6,7} Because of the stability and negative long-term implications (eg, negative peer relations, difficult family relationships, poor academic achievement, unemployment) of externalizing and internalizing problems, and evidence that early interventions improve outcomes,^{8–11} it is important to develop early risk assessment tools^{5,12–14} to trial prevention programs.

In the realm of physical health, tools have been developed to reliably predict cardiovascular disease (CVD) and guide preventive care.¹⁵ Variables such as age, sex, smoking, high blood pressure, diabetes, and dyslipidemia are risk factors for developing CVD. Researchers who have used multivariable risk assessment tools have fostered methods for the identification and early treatment of at-risk individuals who are free of overt CVD symptoms at the time but have overt symptomatology later.¹⁵

Familial aggregation has been shown for most childhood mental health problems.^{16,17} Although it simply describes the clustering of disorders in families, attributable either to shared environmental or genetic influences,¹⁸ genetically sensitive designs have confirmed that heritability plays a much stronger role in familial aggregation than shared environmental processes.^{17,19} A potentially important component of

a risk assessment tool for children's mental health is the mental health of family members. Maternal depression is the most frequently included construct to index familial aggregation in studies that identify risk factors for child psychopathology,²⁰ but authors of nontwin sibling studies also show strong links in the psychopathology of siblings.²¹ Thus, older sibling (OS) psychopathology may be an effective marker for targeting children's risk of later psychopathology.^{17,21} Approximately 80% of children grow up with siblings,²² and 43% have OSs.²³

A range of other factors have been found to predict later psychopathology in children.²⁴ These include infant health, temperament, and sex,^{6,25–28} low income and education,^{29–32} maternal history of adverse childhood experiences (ACEs),³³ family size, age of mother at first pregnancy, single parenthood,^{34–37} and parental negativity and/or harshness.³⁸ These factors have been the most widely examined in the literature and are included in the current study as risk variables.

Early childhood interventions, both educationally based and parenting programs,⁸ have been found to be cost-effective and result in beneficial long-term outcomes.^{39–41} Meta-analytic findings reveal that early interventions have a substantial positive impact on behavioral, cognitive, and health outcomes and that these benefits are sustained over time.⁴² Furthermore, early interventions have been shown to yield high cost-benefit and return rates compared with those administered later in the life course.³⁹ Therefore, creating an early risk assessment tool that would allow for the screening of children before the display of psychopathology may prove particularly valuable for early prevention and intervention.

The majority of studies that identify risk factors for later psychopathology assess risks during the preschool period or later.⁴³ From

18 months onward, it is possible to assess child psychopathology, and early psychopathology is the strongest predictor to date of later psychopathology.^{7,25,44} If, however, the goal is to identify infants before the display of psychopathology or negative caregiver-child-transactional patterns have emerged, then tools with adequate predictive power for later psychopathology are needed. The authors of previous studies have shown that risk prediction in the infancy period is weak²⁴ or has no demonstrated predictive validity.⁴⁵

In the current study, we examine whether the inclusion of OS psychopathology (ie, familial aggregation), as well as previously identified child and family risk factors, increases the predictive power of school-entry (~4.5 years of age) emotional and behavioral problems. The hypothesis was tested that OS psychopathology, when combined with other traditionally assessed risk factors⁴³ during infancy, would enable a moderate level of prediction. The results of this study will inform the future creation of a risk assessment tool that can be administered in infancy to predict school age mental health problems.

METHODS

Sample

In this current study, we used data from the Kids, Families and Places (KFP) study, a longitudinal birth-cohort study of newborns, because families were only recruited if newborns had at least 1 OS. Multiparous women who had been contacted by the Healthy Babies Healthy Children public health program (run by Toronto and Hamilton, ON, Public Health Units) were considered for participation. Inclusion criteria were as follows: (1) English-speaking mother, (2) a newborn singleton (referred to as "target child") weighing at least 1500 g, (3) 1 or more children <4 years old

in the home, and (4) agreement to the collection of observational and biological data. Five hundred one families in Ontario participated in 4 waves of data collection. The KFP sample was similar to the general population of Toronto and Hamilton (2006 census data) in terms of personal income and the number of persons per household but had a lower proportion of nonintact families, fewer immigrants, and more educated mothers.⁴⁶ The University of Toronto Research Ethics Board approved all procedures for this investigation, including informed consent.

Procedure

At each time point, mothers participated in a 2-hour home interview conducted by trained interviewers, and both parents completed paper-and-pencil measures about their family life and each participating child.

Participants

Data came from the first and fourth waves of the KFP study, when the newborn child was 2 months to when he/she was 4.5 years old (ie, at school entry). Henceforth, the first and fourth waves will be referred to as time 1 (T1) and time 2 (T2). Attrition from T1 to T2 was 35.5% ($N = 323$ at T2). Attrition analysis revealed that family dropout was related to social risk: lower maternal age at first pregnancy ($t[494] = -5.10, P < .001$), lower socioeconomic status (SES) ($t[498] = 5.07, P < .001$), lower maternal education ($t[498] = 2.99, P < .005$), and maternal depression ($t[491] = 2.95, P < .005$). Of the participating families, 74% had 2 children living in the home, and the remaining families had 3 or more children living in the home. The mean age of target children at T1 was 2.00 months ($SD = 0.09$), and that of the OSs was 3.16 years ($SD = 1.39$). Regarding sibship sex composition, 21.1% of dyads were boys, 21.7% were girls, and 57.1% were mixed. On average, target

children were 4.5 years old at T2. The mean age of mothers at T1 was 33.50 ($SD = 4.48$) years. In terms of family composition, 93.6% of mothers were married or cohabitating, and 6.1% were divorced, separated, or single (never married). Regarding ethnicity, 51.2% of mothers were of European descent, 15.6% were South Asian, 12.8% were black, and 11.3% were East or Southeast Asian, reflecting the diversity of Southern Ontario. The median of the annual household income was between \$65 000 and \$74 999 Canadian dollars.

Measures

Target Child Internalizing and Externalizing Problems (T2)

Each parent separately reported on the target child's internalizing (ie, emotional) and externalizing (ie, attention and conduct) problems by using scales with well-established psychometric properties from the Ontario Child Health Study (OCHS).⁴⁷ Parents rated statements on a never/not true (1) to often/very true (3) scale, with higher values representing more problems. The emotional scale included 8 statements (eg, seems to be unhappy, sad, or depressed). Internal consistency was adequate for mothers ($\alpha = .706$) and partners ($\alpha = .693$). The attention problems composite included 6 items (eg, can't sit still, is restless or hyperactive). Internal consistency was good for mothers ($\alpha = .81$) and partners ($\alpha = .84$). The conduct problems composite included 6 statements (eg, is destructive, breaks or ruins things on purpose). Internal consistency was good for mothers ($\alpha = .79$) and partners ($\alpha = .77$). Mother and partner reports were correlated for each of the outcomes (emotional $r = 0.48$, attention $r = 0.51$, conduct $r = 0.56$); therefore, a mean was computed to create a composite for each outcome. Utilizing multiple informants for outcome variables enables a more reliable and robust measure of mental health problems.⁴⁸

Familial (Sibling) Risk (T1)

Each parent separately reported on emotional, attention, and conduct problems of the OSs (up to a maximum of 3 siblings) by using scales from the OCHS⁴⁶ at the time of the younger child's birth, as described above. Familial risk was then computed by taking the average of all OSs' internalizing and externalizing problems at T1.

Infant Temperament (T1)

Mothers reported on 5 items making up the fussy-difficult scale from the Infant Characteristics Questionnaire⁴⁹ on a scale of 1 to 7. For example, "How changeable is [name]'s mood?" Scores were summed to yield a mean infant temperament score in which higher scores indicated a more difficult temperament ($\alpha = .67$).

Infant Health (T1)

Mothers rated the general health of their infants (target children) on a scale of 1 (excellent) to 5 (poor) from the OCHS.⁴⁷

Maternal Depression (T1)

Depressive symptomatology was assessed by using the Center for Epidemiologic Studies Depression Scale,⁵⁰ a self-report scale designed to assess depression in nonclinical populations. Mothers rated the frequency of 20 depressive symptoms over the past week by using a 0 (rarely/none of the time) to 3 (most/all of the time) scale, with higher scores representing higher levels of depression ($\alpha = .84$).

ACEs (T1)

Mothers answered a series of questions pertaining to family dysfunction and victimization that occurred to them before the age of 18. All ACEs items were scored as present or absent, and binary scores were summed. A cumulative adversity index was created. See Madigan et al⁵¹ for more information about this measure.

Family Average Maternal Negativity (T1)

Mothers rated 5 items for maternal negativity toward each of the children (over the age of 1.5 years) on a 5-point scale ranging from 1 (never) to 5 (almost always). Negativity items included: “How often do you get angry with your child?” Internal consistency of the scale was $\alpha = .80$. A family average was computed by calculating the mean maternal negativity score across all children (to a maximum of 4) in the family.

SES (T1)

Mothers reported annual household income and family assets (ie, house and car ownership, the number of rooms in the household). Household income was coded on a 16-point scale ranging from no income (1) to \$105 000 or more (16). Values were then standardized. An SES composite was created as assets and income were correlated ($r = 0.69$), with higher scores representing a higher income and/or more assets.

Demographics (T1)

Mothers reported child sex (1 = boy), maternal years of education, number of children in the household, single parenthood (1 = single), and maternal age at first pregnancy.

Data Analysis

Procedure

Analyses were conducted by using SPSS Statistics 24 (IBM SPSS Statistics, IBM Corporation) and Mplus 7.2. We used bivariate correlations to examine relationships between predictor variables and child outcomes. Multiple regressions were conducted by using Mplus with emotional, conduct, and attention problem scores as the outcomes. Each individual's predicted probability score was calculated from this regression equation and used in the receiver operating characteristic (ROC) analyses. Outcome variables at T2 (ie, emotional, conduct, and attention problems) were

TABLE 1 Bivariate Correlations Between Risk Factors at T1 and Emotional, Conduct, and Attention Problems at 4-year Follow-up ($N = 323$)

Risk Variables	Emotional Problems	Conduct Problems	Attention Problems
Emotional problems OS(s)	0.32***	0.08	0.20***
Conduct problems OS(s)	0.11*	0.36***	0.15***
Attention problems OS(s)	0.12**	0.19***	0.31***
Girl	-0.05	-0.12**	-0.12**
Infant temperament	0.14**	0.13**	0.15***
Infant health	0.18***	0.05	0.08
SES	-0.27***	-0.10*	-0.15**
Maternal age first pregnancy	-0.09*	-0.10**	-0.18***
Single parenthood	0.13**	0.12**	0.11**
Maternal education	-0.12**	-0.02	-0.04
No. of children in house	-0.05	0.04	0.02
Maternal depression	0.28***	0.06	0.10*
Mother ACEs	0.03	0.18***	0.13**
Family average maternal negativity	0.11*	0.08	0.15***

*** $P < .01$;

** $P < .05$;

* $P < .1$.

dichotomized to conduct the ROC analysis on the basis of a 15% cutoff (1 = top 15%, 0 = remaining 85%) following usual practice.⁵²

Missing Data

All predictor and outcome variables had minimal missing data (<5%). To handle missing data, Full Information Maximum Likelihood Estimation (available in Mplus) was used. Full Information Maximum Likelihood is used to estimate model parameters and SEs by using available information and is considered superior with respect to efficiency and bias compared with other techniques, such as listwise deletion and multiple imputations.⁵³

RESULTS

In Table 1, we show bivariate correlations between predictor and outcome variables. Associations were in the small to moderate range and in the expected directions. The strongest correlation with target child emotional problems was OS(s) emotional problems ($r = 0.32$). This pattern of results was the same for conduct ($r = 0.36$) and attention problems ($r = 0.31$). SES and maternal depression were also moderately correlated with child emotional problems. The same 12 risk predictors were included in the regression analysis for each child outcome.

Significant predictors ($P < .05$) for emotional problems can be seen in Table 2 and included (in order of magnitude) emotional problems in OSs, maternal depression, and SES, with number of children in household significant at $P < .10$. The area under the ROC curve (Fig 1) was 0.75 (95% confidence interval [CI], 0.68–0.82), indicating a fair level of accuracy of prediction.

Significant predictors ($P < .05$) for conduct problems can be seen in Table 3 and included conduct problems in OSs, boys, and infant health, with infant temperament and maternal ACEs significant at $P < .10$. The area under the ROC curve (Fig 2) was 0.74 (95% CI, 0.67–0.82), indicating a fair level of prediction.

Significant predictors ($P < .05$) for attention problems (see Table 4) included attention problems in OSs, sex, and infant temperament, with maternal age at first pregnancy significant at $P < .10$. The area under the ROC curve (not shown) was 0.67 (95% CI, 0.60–0.75). Hence, the accuracy of the prediction of attention problems was inadequate.

Further analyses were conducted. First, mean age and sex composition of OSs (coded as all boys, all girls, and mixed) were examined to determine if they were predictive of target children's

own mental health problems. Age of OSs was not a significant predictor of any outcome. Sex composition was a significant predictor for attention problems (children with male OSs showed higher attention problems), but the inclusion of this construct still did not result in an acceptable ROC (0.7). Second, prediction analyses were conducted without OS emotional and behavioral scores to determine if fair prediction was possible in the absence of sibling data. The degree of prediction (and the consequent ROCs) were unsatisfactory for all outcomes. Third, to ensure that results could not simply be explained by shared informant bias (ie, the correlation between 2 siblings on behavior is attributable to the same person reporting on both children) analyses were redone with mothers reporting on sibling behavior and fathers reporting on target child behavior. The pattern of results was similar to those reported above, supporting the conclusion that siblings show similarities in mental health that are not only because of shared informant bias.

DISCUSSION

Our goal for the current study was to examine the plausibility of a risk assessment tool in infancy that included OS psychopathology as a predictor. Results revealed that the emotional, conduct, and attention problems of OSs at the birth of the newborn were the strongest predictors of the same problems in target children 4 years later, which is in line with results from the Ma et al²¹ meta-analysis, which showed that nontwin siblings of children with psychopathology are at an increased risk for developing internalizing and externalizing problems. The importance of this finding is not the presence of familial aggregation because this has been well-documented,^{17,21} but rather that by including this concept in prediction analyses, it becomes possible to achieve a fair level of accuracy in

TABLE 2 Standardized and Unstandardized Regression Coefficients for Risk Factors at T1 in the Prediction of Emotional Problems at T2

Risk Variables	b	SE	β	P
Emotional problems OS(s)	0.26	0.06	.26	.000
Girl	-0.11	0.08	-.07	.169
Infant temperament	0.05	0.04	.06	.290
Infant health	0.09	0.07	.09	.155
SES	-0.16	0.07	-.16	.022
Maternal age first pregnancy	0.01	0.01	.04	.491
Single parenthood	0.00	0.25	.00	.997
Maternal education	-0.01	0.02	-.03	.605
No. of children in house	-0.09	0.07	-.09	.102
Maternal depression	0.02	0.01	.17	.005
Mother ACEs	-0.00	0.03	-.01	.892
Family average maternal negativity	0.01	0.07	.01	.864

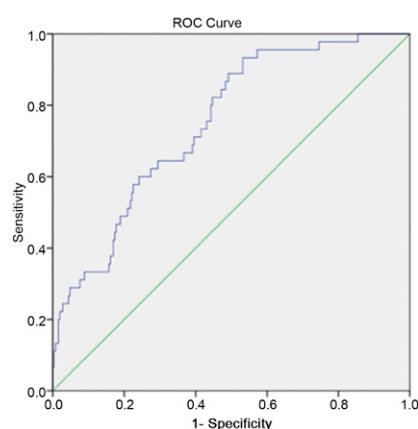


FIGURE 1 ROC curve for emotional problems at 4-year follow-up (T2).

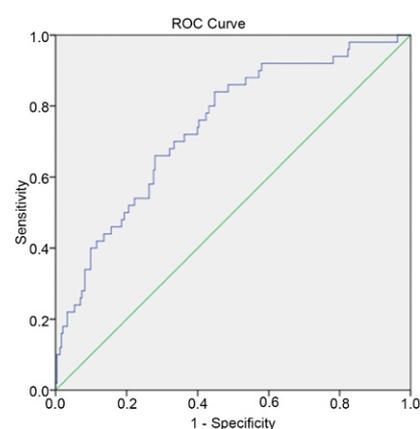


FIGURE 2 ROC curve for conduct problems at 4-year follow-up (T2).

TABLE 3 Standardized and Unstandardized Regression Coefficients for Risk Factors at T1 in the Prediction of Conduct Problems at T2

Risk Variables	b	SE	β	P
Conduct problems OS(s)	0.46	0.08	.36	.000
Girl	-0.22	0.10	-.11	.029
Infant temperament	0.09	0.05	.09	.076
Infant health	-0.20	0.07	-.15	.003
SES	-0.08	0.08	-.06	.343
Maternal age first pregnancy	-0.01	0.01	-.03	.594
Single parenthood	0.26	0.31	.06	.399
Maternal education	0.03	0.02	.07	.262
No. of children in house	-0.02	0.6	-.01	.802
Maternal depression	-0.00	0.01	-.03	.594
Mother ACEs	0.05	0.03	.10	.081
Family average maternal negativity	-0.07	0.09	-.04	.447

the prediction of emotional and behavioral problems from birth to school entry. Without the scores on emotional and behavioral problems of OSs, the level of prediction would have been unsatisfactory. It is also notable that risk prediction for school-entry attention problems was also not satisfactory.

The other factors that were included in the prediction analyses have each been identified in previous studies as risk factors for child psychopathology. However, these risk factors provided weak and inconsistent prediction that on their own would not have been sufficient for valid risk prediction. SES and maternal depression

TABLE 4 Standardized and Unstandardized Regression Coefficients for Risk Factors at T1 in the Prediction of Attention Problems at T2

Risk Variables	b	SE	β	P
Attention problems OS(s)	0.32	0.07	.30	.000
Girl	-0.22	0.10	-.12	.029
Infant temperament	0.11	0.05	.11	.036
Infant health	-0.02	0.07	-.01	.803
SES	-0.07	0.08	-.06	.407
Maternal age first pregnancy	-0.02	0.01	-.10	.103
Single parenthood	0.21	0.30	.05	.465
Maternal education	0.03	0.02	.08	.126
No. of children in house	-0.03	0.06	-.03	.644
Maternal depression	-0.00	0.01	.02	.696
Mother ACEs	0.04	0.03	.07	.211
Family average maternal negativity	0.09	0.10	.06	.368

significantly predicted later emotional problems, whereas infant sex, infant temperament, infant health, and maternal depression predicted later conduct problems. Infant sex and temperament predicted later attention problems. In contrast to previous studies, factors such as maternal ACEs were not significantly predictive of emotional or behavioral problems.

The main implication resulting from this study is that sibling psychopathology is the strongest predictor of children's later mental health and raises risk assessment to an acceptable level of prediction. Consequently, this construct should be included when developing future risk assessment tools. It is noteworthy that identification of infants at risk for autism, on the basis of their OSs' diagnosis of autism, has led to a successful prevention trial for the younger siblings.^{54,55} There is significant value in determining if a prevention trial targeted at newborns whose OSs suffer from common psychopathologies (ie, internalizing and externalizing problems) can reduce the newborn's subsequent psychopathology. In pediatric and community mental health settings, OS psychopathology is an important risk factor to be queried and included in newborn risk assessment of health care professionals working with infants and children.

Despite these findings, the greatest limitation of this study is the lack

of generalizability to firstborn children. The predictive value of OS psychopathology raises the possibility that risk prediction could be significantly enhanced in the infancy period by a much broader assessment of the biological parents' psychopathology. Although most studies only include an assessment of maternal depression, future studies would benefit from measures of mother and father psychopathology in adulthood and childhood (eg, delinquent and antisocial behavior, substance abuse, attention deficit, anxiety, depression) to determine if such measurements could enhance the prediction of school-entry psychopathology for firstborn children.⁵⁶⁻⁵⁸ A second limitation of the study is that parents served as informants for both the OS(s) and the target child's mental health problems. Although the inclusion of both parents and the 4-year time gap between OS and target child measurement reduces concerns that results are driven by shared informant bias, these concerns cannot be eradicated. In future studies, it will be of value to include teacher informants or observational data. Third, findings generalize to families that are of somewhat higher SES than the general population, given the pattern of sample attrition. Finally, it will be beneficial to replicate results in a larger independent sample, investigate ease of administration in a clinical setting, and include diagnostic instruments in future work.

CONCLUSIONS

The addition of sibling psychopathology as a risk factor enables a fair level of prediction of school-entry psychopathology. Prevention programs for children at high risk of emotional and behavioral problems have been shown to be effective and economically beneficial,^{8,39,55,59} which supports the argument for the inclusion of this risk factor in the future creation of infant risk assessment tools.

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ABBREVIATIONS

ACE: adverse childhood experience
 CI: confidence interval
 CVD: cardiovascular disease
 KFP: Kids, Families and Places
 OCHS: Ontario Child Health Study
 OS: older sibling
 ROC: receiver operating characteristic
 SES: socioeconomic status
 T1: time 1
 T2: time 2

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