Exploring Risk Factors for the Emergence of Children’s Mental Health Problems

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Context: Exploratory studies that generate testable models of how risk factors for childhood mental health problems work together over time are critical for developing effective prevention and treatment strategies.

Objective: To build models addressing the following 2 questions: (1) How early can we identify children at risk for mental health problems in third grade? (2) How do the risk factors work together over time?

Design and Participants: We assessed a Wisconsin community sample 8 times, beginning during pregnancy. Three hundred seventy-nine families completed multi-informant reports (mothers, teachers, and children) of children’s mental health symptoms in third grade.

Main Outcome Measures: Symptom severity and directionality (externalizing vs internalizing).

Results: The hypothesis was generated that family socioeconomic status (SES) defined different pathways to symptom severity. In low/middle SES families, children were at risk if their mothers were distressed during the infancy period, which was then associated with more generalized maternal and child distress and dysregulation during the preschool period. In high SES families, the picture was more complex, beginning with parental histories of depression and family psychopathology, which then led to greater family stress in the infancy period and maternal and child distress and dysregulation during the preschool period. For all children, social and academic impairment during the school transition was an important mediator. Two pathways to later symptom directionality consisted of one beginning with child sex and the other with child temperament.

Conclusions: Most risk factors predicted symptom severity and not directionality. The risk factors for internalizing and externalizing problems may be much the same, and the same preventive interventions might be effective for both classes of problems. Furthermore, at-risk children from high SES families might be identifiable as early as infancy, whereas those from lower SES families may be identifiable only as preschoolers.

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AMBIGUITIES ABOUND IN RESEARCH ON CHILDREN’S MENTAL HEALTH, FOR SEVERAL REASONS. MOST IMPORTANTLY, ALTHOUGH AN EXTENSIVE BODY OF RESEARCH EXAMINES RISK FACTORS FOR CHILDHOOD MENTAL HEALTH PROBLEMS, HOW RISKS IN DIFFERENT DEVELOPMENTAL PERIODS WORK TOGETHER IS LARGELY UNKNOWN. THIS IS PRIMARILY DUE TO THE OVEREMPHASIS ON HYPOTHESIS TESTING, OFTEN DONE PREMATURELY. TO FORMULATE STRONG HYPOTHESES TO TEST AND TO INFORM POWERFUL DESIGN DECISIONS, WELL-PERFORMED EXPLORATORY STUDIES ARE NEEDED. HOWEVER, EXPLORATORY STUDIES ARE DISCOURAGED, OFTEN DISMISSED AS “FISHING EXPEDITIONS” OR “DATA DREDGING.”

The present study addresses conceptual and methodological issues in the study of childhood mental health problems. Most importantly, it uses a structured exploratory approach to generate hypotheses regarding risk factors for the emergence of children’s mental health problems for testing in future studies of this and other populations of children. Such studies are critical for developing effective prevention and treatment strategies.

RISK FACTORS FOR CHILDHOOD MENTAL HEALTH PROBLEMS

Several theoretical frameworks articulate how risk factors for childhood mental health problems may work together over time, each emphasizing the need to consider multiple domains of risk factors during multiple developmental periods. However, with a few notable exceptions, studies are limited in their coverage of risk factors and developmental periods, resulting in ambiguity in their findings. Boys evidence more externalizing problems than girls, but until adolescence, sex differences in internalizing problems are inconsistent. Gestational and perinatal exposures are often, but not always, associated with externalizing problems. Children’s withdrawal-related emotional biases (eg, behavioral inhibition, sadness) are associated with later

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internalizing problems, but the association of approach-related characteristics (eg, anger proneness, low inhibitory control) with later externalizing problems is less clear. Early family factors (eg, socioeconomic status [SES], family histories of psychopathology, marital and family conflict, and parent-child relationship) and later social and academic impairments are associated with both classes of problems.

CONCEPTUAL AND METHODOLOGICAL ISSUES

Several conceptual and methodological issues contribute to the ambiguity in findings. First, there is a lack of comprehensive, multi-informant measures of health for young children. To address this issue, we developed instruments to obtain parallel parent, teacher, and child reports of children's health and functioning. To deal with the problem of how to handle discrepant reports from multiple informants, we demonstrated that the careful selection of reporters who view the child from different perspectives (eg, child self-view vs adult view) and in different contexts (eg, home vs school) can be used to measure a core characteristic (eg, internalizing symptoms) by removing the sources of error that result from reporters' differing perspectives and contexts.

A second problem stems from a failure to deal adequately with the epidemiological comorbidity of childhood internalizing and externalizing problems. Not only are these problems often comorbid, but evidence suggests that risk factors for either appear much the same. To address this issue, we proposed to distinguish what the 2 problem domains have in common (Severity = E + I/2) from what differentiates them (Directionality = E − I/2), where E indicates externalizing problems and I indicates internalizing problems. Risk factors for severity are non-specific; those for directionality are specific factors to only 1 of the 2 problem domains or are correlated in opposite directions. Importantly, severity and directionality are independent and thus can be analyzed separately without exacerbating type I error.

Third, because documenting risk factors requires demonstration of temporal precedence, longitudinal studies are necessary. However, when risk factors are identified, typically any single factor explains only a small proportion of variance in the outcome. Clearly risk factors work together in some way, and understanding how they do so is vital. To address this issue, we expanded and modified the classic approach to moderators and mediators.

PRESENT STUDY

As an example of these approaches, we applied them to a longitudinal study of child development. We focused on third-grade mental health symptoms and, based on theory and prior evidence, a set of possible risk factors from multiple developmental periods beginning prenatally. Two major questions were addressed: (1) How early can we identify children at risk for mental health problems in third grade (hereafter referred to as third-grade mental health problems)? and (2) How do the risk factors work together to explain the emergence of mental health problems? Our primary goal was to build a model of this process to generate hypotheses for testing in future studies of this and other populations of children, and to provide a template for use in other longitudinal studies.

METHODS

THE MacARTHUR MODERATOR-MEDIATOR APPROACH

The MacArthur moderator-mediator approach is a structured exploratory approach to identifying risk factors for an outcome and the ways in which they work together as moderators and mediators. The basic requirement is a sample representative of a population and a well-constructed set of longitudinal data relevant to a well-measured outcome. The approach is a stepwise process in which potential risk factors are ordered by time and domain and then subjected to statistical criteria. The statistical criteria, chosen by the investigator before initiating the study, must be set for significance level (herein, .05) and what level of correlation is considered of practical significance (herein, |r| ≥ .20). The choice involves a balancing of false-positive and false-negative findings. With less stringent criteria, more risk factors would be detected, but there would be more false-positive results. With more stringent criteria, fewer risk factors would be detected, but there would be more false-negative results.

The model used to examine how 2 risk factors, A and B, jointly predict the outcome is a multiple linear regression model, including A, B, and the A × B interaction, with binary variables coded +1/2 and −1/2, and ordinal variables coded as deviations from their mean. The definitions of proxy, overlapping, mediator, moderator, and independent risk factors are specified in Table 1. When proxy, mediator, or independent risk factors are found, no further decisions are required. However, further decisions are required for overlapping or moderator risk factors. For overlapping risk factors, the approach requires that a single measure of their common construct be identified for further analysis. With a single exception, we chose to use the first principal component because this procedure is quite robust with only 2 variables. For moderators, the approach requires that the sample be split. If the moderator is binary, the question of how to split the sample is obvious. When the moderator is scaled, some trial and error may be necessary to determine how to form subgroups to best account for the interaction detected.

Step 1 is to select the constructs that theory and prior evidence indicate might be risk factors for the outcome. Constrains are organized by time and domain. To the greatest extent possible, the constructs should be at least conceptually independent.

Step 2 is to examine the association between each potential risk factor and the outcome, using the statistical criteria set a priori to identify risk factors.

Step 3 is to identify which risk factors within a time period are independent, proxy, or overlapping. Proxy risk factors are omitted from further analysis. For overlapping risk factors, a single measure is constructed to replace the overlapping variables, as already discussed. Analyses are conducted within domains and then across domains, resulting in a set of independent risk factors within each time period.

Step 4 is to connect the risk factors across time and to identify them as mediators or moderators. When a mediator is demonstrated, it suggests a path linking risk factors across time periods to the outcome; multiple mediators suggest multiple paths. When a moderator is demonstrated, it suggests...
multiple paths leading to the outcome that differ depending on the level of the moderator. Thus, the sample is split into subgroups, and the analysis begins again at step 2 for each subgroup. This process is repeated from each time period to the next, resulting in 1 or more structural paths linking risk factors to the outcome. All analyses were conducted using computer software specifically designed for this exploratory approach,46 which becomes increasingly tedious and difficult to organize as the number of potential risk factors and time periods increase.

PARTICIPANTS

The children in this study are participants in a longitudinal study, the Wisconsin Study of Families and Work.26 Originally, 570 pregnant women and their partners were recruited from prenatal clinics in 2 Midwestern cities to participate in a study of maternity leave and health outcomes.49 Female participants were required to be older than 18 years, in the second trimester of pregnancy, living with the infant’s biological father, and employed or a full-time homemaker. Of those eligible to participate, 75.4% agreed. All study procedures were approved according to the University of Wisconsin institutional guidelines; informed consent was obtained from all adult participants.

The present analyses included the 379 families with complete mother, teacher, and child reports of children’s third-grade mental health symptoms. At the time of the third-grade assessment, 78.6% (n=468) of the original sample remained in the study. Of these, 69 participated in only the maternal interview and thus were not included in the present analyses. At the time of recruitment, 44.6% of the 379 mothers and 49.0% of the 367 participating fathers had a high school or technical degree or less, and the remainder had at least a college degree. The average ages of the mother and father were 29.7 (SD, 4.3) and 31.6 (SD, 5.2) years, respectively, and 41.2% of the mothers were expecting their first child. Most couples were married (95.5%) and white (89.9%); median annual family income was $48 000 (range, <$10 000 to >$200 000). There were no statistically significant differences between the 379 participants and the remaining families in the original sample in terms of the father’s education, marital or ethnic status, or annual family income, but there were minor differences in parental age and the mother’s education: compared with the participants, the nonparticipating parents were 1 year younger (mean ages of mothers, 28.7 vs 29.7 years [t156=−2.72; P=.007]; mean ages of fathers, 30.6 vs 31.6 years [t156=−2.31; P=.02]), and the nonparticipating mothers had a half-year less education (14.7 vs 15.2 mean years of education [t156=−2.61; P=.009]).

MEASURES

Table 2 shows the constructs selected in step 1 as potential risk factors for third-grade mental health problems. These constructs were measured with 56 variables, many of which are well established and have been described in previous reports.26,27 Because of the large number of variables, only those that are critical for understanding the results are described. Except where noted, measures are adult reports using rating scales. The internal consistency (coefficient α) for all measures exceeded 0.70.

Prenatal/Birth Measures

Family SES was assessed with parental educational level and total annual household income. Maternal family history of psychopathology was assessed with maternal reports of the number of first-degree relatives with a history of depression or mania, suicide, or alcohol, other drug, or antisocial problems. To assess maternal lifetime history of depression, mothers were asked if they had ever experienced an episode of depression and, if so, their age at first onset and treatment history. Maternal and paternal depression symptoms were assessed with the Center for Epidemiological Studies—Depression Scale,31 the highest of the maternal or paternal score was defined as maximum parental depression symptoms.

Infancy Measures

Scores were averaged over the 1-, 4-, and 12-month assessments. Marital conflict was assessed with maternal and paternal reports of the average of 3 items (eg, concerned about arguing or fighting) from the Marital Role-Quality Scale.32 Maternal

### Table 1. Types and Definitions of Risk Factors*

<table>
<thead>
<tr>
<th>Types of Risk Factors†</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>B is proxy to A if</td>
<td>(1) A and B refer to the same time period (within-time analyses) or A precedes B (across-time analyses)</td>
</tr>
<tr>
<td>A is overlapping with B if</td>
<td>(2) A and B are correlated with each other</td>
</tr>
<tr>
<td>B mediates A if</td>
<td>(3) Only A predicts the outcome (b2 and b3 both equal 0)</td>
</tr>
<tr>
<td>A moderates B if</td>
<td>(1) A precedes B</td>
</tr>
<tr>
<td>A and B are independent if</td>
<td>(2) A and B are not correlated</td>
</tr>
</tbody>
</table>

*The linear model used is \( y = b_0 + b_1A + b_2B + b_3AB \), where A and B (representing risk factors) are both centered,\(^\text{47}\) ie, coded +1/2 and −1/2 if binary, and coded as deviations from the sample mean if ordinal, and where O indicates the outcome variable and \( b \) represents the regression coefficients for the intercept \( (b_0) \), risk factor A \( (b_1) \), risk factor B \( (b_2) \), and their interaction \( (b_3) \). †By definition, all risk factors\(^\text{2,46}\) are correlated with the outcome of interest at a level that meets or exceeds prespecified criteria for strength of association and significance level.
Two measures, maternal report and observational, were constructed for each of the following 3 aspects of child emotions and behaviors: withdrawal–related negativity, approach–related negativity, and behavioral dysregulation. Maternal report was based on subscales of the Children’s Behavior Questionnaire,58 averaged across the 2 preschool assessments, including fear, sadness, and shyness; anger; and the reverse of inhibitory control. Observational measures were based on videotaped ratings of children’s behaviors during a 2-hour home-based assessment at 4½ years of age, which included a series of emotion-eliciting tasks and mother–child interaction tasks.57 Two sets of observational measures were obtained. First, global ratings were made by 2 research assistants who observed the children throughout the visit. After the visit, both observers reviewed the videotape and independently rated the child on a set of items characterizing emotional and behavioral tendencies; perfect agreement was obtained for at least 75% of the ratings. Second, microlevel ratings (ie, latencies, durations, frequencies; perfect agreement was obtained for at least 75% of the raters) based on subscales of the Children’s Behavior Questionnaire were made independently by 2 raters who had not directly observed the assessment. The global and microlevel ratings were combined to form observational measures of withdrawal–related negativity (ie, reverse-coded exploratory behaviors, shyness, fear, and sadness), approach–related negativity (ie, anger), and behavioral dysregulation (ie, impulsivity and low inhibitory control).

To assess family-expressed anger, marital conflict scores (previously defined in the “Infancy Measures” subsection) were combined with average parental scores for anger expression and negative family expressiveness.59 Maternal, paternal, and maximum parental distress were assessed in the same manner as in the infancy period. Maternal negativity toward the child was based on videotaped observations of the mother–child interactions during the 4½-year home visit according to the global rating procedures described in the previous paragraph. Four items were averaged tapping the degree of maternal disapproval/criticism, lack of connectedness, inability to read cues, and intrusiveness.

### Table 2. Potential Risk Factors for Symptom Severity and Directionality in Third Grade (Step 1)*

<table>
<thead>
<tr>
<th>Domain</th>
<th>Prenatal (Second Trimester/Birth)</th>
<th>Infant (Ages 1, 4, and 12 mo)</th>
<th>Preschool (Ages 3½ and 4½ y)</th>
<th>School Transition (First Grade)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child biology</td>
<td>Sex, Gestational and perinatal exposures (2), Birth complications (6)</td>
<td>Emotional reactivity and regulation: Approach-related negativity Withdrawal-related negativity Behavioral dysregulation</td>
<td>Physical health: Frequency of illness and No. of physician visits Chronic conditions</td>
<td>Receptive language abilities Academic competence School engagement Prosocial behaviors Social inhibition Asocial behaviors</td>
</tr>
<tr>
<td>Child cognitive functioning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child emotions and behaviors</td>
<td>Emotional reactivity and regulation: Approach-related negativity Withdrawal-related negativity Behavioral dysregulation Parental involvement (2) Marital conflict (2) Parental distress (3) (depression symptoms, role overload, parenting stress, and financial stress)</td>
<td>Parental involvement (2) Marital conflict (2) Parental distress (3) (depression symptoms, role overload, parenting stress, and financial stress)</td>
<td>Parental separation/divorce Family expressed anger (2) Maternal negative behaviors toward child Parental distress (3) (same as infancy)</td>
<td></td>
</tr>
<tr>
<td>Family context</td>
<td>Parental age (3) No. of children in household Family SES Maternal family history of psychopathology (4) Maternal lifetime history of depression Parental depression symptoms (3)</td>
<td>Maternal involvement (2) Marital conflict (2) Parental distress (3) (depression symptoms, role overload, parenting stress, and financial stress)</td>
<td>Maternal lifetime history of depression Maternal depression symptoms (3)</td>
<td>Teacher–child relationship (2) Peer relations</td>
</tr>
<tr>
<td>School context</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviation: SES, socioeconomic status. *Variables total 56; numbers in parentheses indicate the number of variables for each construct. No parentheses indicates only a single variable.

and paternal distress were assessed with each parent’s perceptions of their depression symptoms and stress in the areas of parenting, role overload, and finances.60 The highest of the 2 parental distress scores was defined as the maximum parental distress.

### Preschool Measures

Two measures, maternal report and observational, were constructed for each of the following 3 aspects of child emotions and behaviors: withdrawal–related negativity, approach–related negativity, and behavioral dysregulation. Maternal report was based on subscales of the Children’s Behavior Questionnaire averaged across the 2 preschool assessments, including fear, sadness, and shyness; anger; and the reverse of inhibitory control. Observational measures were based on videotaped ratings of children’s behaviors during a 2-hour home-based assessment at 4½ years of age, which included a series of emotion-eliciting tasks and mother–child interaction tasks. Two sets of observational measures were obtained. First, global ratings were made by 2 research assistants who observed the children throughout the visit. After the visit, both observers reviewed the videotape and independently rated the child on a set of items characterizing emotional and behavioral tendencies; perfect agreement was obtained for at least 75% of the ratings. Second, microlevel ratings (ie, latencies, durations, frequencies; perfect agreement was obtained for at least 75% of the raters) based on subscales of the Children’s Behavior Questionnaire were made independently by 2 raters who had not directly observed the assessment. The global and microlevel ratings were combined to form observational measures of withdrawal–related negativity (ie, reverse-coded exploratory behaviors, shyness, fear, and sadness), approach–related negativity (ie, anger), and behavioral dysregulation (ie, impulsivity and low inhibitory control).

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### Transition-Into-School Measures

The Peabody Picture Vocabulary Test–Revised assessed children’s receptive language abilities. All other first-grade measures were obtained from teacher reports based on the MacArthur Health and Behavior Questionnaire, which includes scales adapted from well-established measures of children’s academic competence, prosocial behaviors, school engagement, social inhibition, teacher–child conflict, and peer relations.

### Third-Grade Mental Health Symptoms

Mother and teacher reports of children’s third-grade mental health symptoms were based on the MacArthur Health and Behavior Questionnaire. Child self-reports were based on an age-appropriate modification of the Berkeley Puppet Interview–Symptomatology module. Internalizing symptoms included subscales for depression, generalized anxiety, and separation anxiety. Externalizing symptoms included subscales for oppositional defiance, conduct problems, inattentiveness, impulsivity, overt aggression, and relational aggression. As described in the “Conceptual and Methodological Issues” subsection of the Introduction, 2 multi-informant core scores measured symptom severity (average of the 2 standardized scores) and directionality (half difference of the standardized scores; positive score indicates a preponderance of externalizing vs internalizing symptoms and a negative score indicates the reverse).
RESULTS

RISK FACTORS FOR SYMPTOM SEVERITY

The first goal was to develop a model of third-grade symptom severity. After identifying the independent risk factors within time, the across-time analyses showed that family SES moderated the association of preschool child behavioral dysregulation with symptom severity (interaction $\beta = -0.11; P = .02$), suggesting that the risk factors differ for children raised in different SES families and that the sample needed to be split into SES subgroups.

To select an appropriate cut point to define the subgroups, we used parental education because it is more easily interpreted than the SES composite. We initially defined subgroups where (1) neither parent, (2) only 1 parent, or (3) both parents had a college education, then compared the regression lines predicting symptom severity from preschool child behavioral dysregulation (Figure 1). Because the low and middle SES subgroups showed similar results that were different from the high SES subgroup, we combined these 2 subgroups (hereafter referred to as the low/middle and high SES subgroups). As expected, the low/middle SES subgroup had lower family incomes (mean, $46,787; SD, $21,459) than did the high SES subgroup (mean, $57,263; SD, $24,193) ($t_{371} = -4.40; P < .001$). Children in the low/middle SES subgroup exhibited more severe third-grade symptoms (mean, 0.12; SD, 0.85) than did children in the high SES subgroup (mean, -0.17; SD, 0.90) ($t_{374} = 3.16; P = .002$).

Low/Middle SES Subgroup

Beginning again with step 2, 13 (23%) of the 56 potential risk factors were identified as risk factors for symptom severity for the low/middle SES subgroup (Table 3).

To illustrate the within-time analyses (step 3), we provide a detailed example for the preschool period (Figure 2). Within the domain of child emotions and behaviors, maternal report and observations of child approach-related negativity and behavioral dysregulation were shown to predict low/middle SES symptom severity.

Table 3. Identified Risk Factors for Grade 3 Symptom Severity in Third Grade by Low/Middle and High SES Subgroups (Step 2)*

<table>
<thead>
<tr>
<th>Domain</th>
<th>Prenatal (Second Trimester)/Birth</th>
<th>Infancy (Ages 1, 4, and 12 mo)</th>
<th>Preschool (Ages 3½ and 4½ y)</th>
<th>School Transition (First Grade)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child biology</td>
<td></td>
<td>Maternal report of child chronic conditions†</td>
<td>Receptive language abilities (standardized test)‡</td>
<td>Teacher report: Academic competence†‡</td>
</tr>
<tr>
<td>Child cognitive functioning</td>
<td></td>
<td>Teacher report: Approach-related negativity‡‡ Behavioral dysregulation‡‡</td>
<td>Teacher report: School engagement† Peer relations‡‡</td>
<td></td>
</tr>
<tr>
<td>Child emotions and behaviors</td>
<td></td>
<td>Maternal report of marital conflict† Paternal report of marital conflict†</td>
<td>Maternal report of separation/divorce† Maternal report of family-expressed anger†</td>
<td>Maternal negative behaviors toward child (observed)‡ Maternal report of distress‡‡ Maximum parental distress‡‡</td>
</tr>
<tr>
<td>Family context</td>
<td>Maternal report of family history of psychopathology† Maternal report of lifetime history of depression† Maternal report of depression symptoms† Maternal report of distress‡ Maximum parental distress†</td>
<td>Maternal report of distress‡‡ Maximum parental distress‡‡</td>
<td>Teacher report: Teacher-child conflict‡ Peer relations‡‡</td>
<td></td>
</tr>
<tr>
<td>School context</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviation: SES, socioeconomic status.
*Indicates potential risk factors from Table 2 that met prespecified statistical criteria of $|\beta| > 0.20$ and $P < .05$ for identifying risk factors. Measurement of SES is explained in the “Measures” subsection of the “Methods” section and the legends to Figures 2 through 4.
†Indicates high SES.
‡Indicates low/middle SES.
Within-Domain Analyses

- Observed Child Approach-Related Negativity
- Maximum Parental Distress

Across-Domain Analyses

- Observed Maternal Negativity Toward Child
- Child Behavioral Dysregulation
- Maternal and Child Distress and Dysregulation

**Table 4. Risk Factors Demonstrated to Be Proxy, Overlapping, or Independent Within Time for Symptom Severity in Third Grade Among Low/Middle SES Children (Step 3)**

<table>
<thead>
<tr>
<th>Proxy Risk Factors†</th>
<th>Overlapping Risk Factors (ρ)‡</th>
<th>Independent Risk Factors Within Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prenatal/Birth Period</strong></td>
<td>No prenatal/birth risk factors</td>
<td></td>
</tr>
<tr>
<td><strong>Infancy Period</strong></td>
<td>(1) Maternal distress</td>
<td></td>
</tr>
<tr>
<td><strong>Preschool Period</strong></td>
<td>Maternal distress (0.74)</td>
<td>(2) Maternal and child distress and dysregulation—A</td>
</tr>
<tr>
<td>Maternal report:</td>
<td>Maternal distress (0.74)</td>
<td></td>
</tr>
<tr>
<td>Child approach-related negativity</td>
<td>Maximum parental distress (0.59)</td>
<td></td>
</tr>
<tr>
<td>Maternal report:</td>
<td>Observed:</td>
<td></td>
</tr>
<tr>
<td>Child behavioral dysregulation (0.55)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal report:</td>
<td>Child behavioral dysregulation (0.75)</td>
<td></td>
</tr>
</tbody>
</table>

**School Transition Period**

| Teacher report: | Child social and academic impairment—A |

- Child receptive language abilities (−0.57)
- Child academic competence (−0.74)
- Teacher-child conflict (0.60)
- Child peer rejection/bullied (0.70)

Abbreviation: SES, socioeconomic status.

†Of the 13 identified risk factors in Table 3, 4 were demonstrated to be proxies and were omitted from further analysis.

‡Spearman correlations of individual overlapping risk factors (4 in the preschool period and 4 in the school transition period) with resulting composite independent risk factor within time. The italicized risk factor is the only one that was dropped rather than combined because it contained the same measure as that with which it overlapped (maternal distress) and it was less strongly associated with the outcome.

approach-related negativity were proxies to maternal report and observations (respectively) of child behavioral dysregulation and were omitted from further analyses; and maternal report and observed child behavioral dysregulation were overlapping and combined into a single measure. Within the family domain, maximum parental distress overlapped with maternal distress. This was the only situation in which overlapping factors contained the same variable (maternal distress); because maternal distress was more strongly associated with the outcome, we selected it and omitted maximum parental distress from further analysis. Next, in the across-domain analyses, observed maternal negativity toward the child was omitted because it was proxy to child behavioral dysregulation. Maternal distress and child behavioral dysregulation were overlapping and were combined into a final composite variable tapping maternal and child distress and dysregulation.

Within the school transition period, we followed a similar process. All within-time analyses (step 3) are summarized in Table 4, which shows the original 13 identified risk factors and distinguishes those demonstrated to be proxies (omitted from further analyses) or overlapping (combined), from the final 3 independent risk factors that were included in the across-time analyses.

The results of the across-time analyses (step 4) are shown in Figure 3. Maternal distress in the infancy period leads to maternal and child distress and dysregulation in preschool, which is partially mediated by child

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social and academic impairment during the school transition. Of note is the poor ability of the infancy risk factor to predict symptom severity ($R^2=0.09$) and the considerably greater predictive power that is gained with the risk factors in the preschool ($R^2=0.26$) and school transition ($R^2=0.36$) periods.

**High SES Subgroup**

Beginning with step 2, 21 (38%) of the 56 factors were identified as risk factors for symptom severity for the high SES subgroup (Table 3). Using the same principles as described above, within-time analyses were conducted to define the risk factors within each time period as proxies, overlapping, or independent (step 3). The results are summarized in Table 5. Of note is that although the independent risk factors identified in the preschool and school transition periods represented the same constructs as those for the low/middle SES subgroup, there were several differences in the overlapping risk factors that constitute those constructs. These differences in the composition of the same constructs are denoted as A (low/middle SES subgroup) and B (high SES subgroup) in Figure 3 and Figure 4.

The results of the across-time analyses (step 4) are shown in Figure 4. This model was more complicated than the model for the low/middle SES subgroup, beginning with 3 prenatal risk factors. Maternal lifetime history of depression, maximum prenatal parental depression symptoms, and maternal family history of psychopathology were each partially mediated by family distress in infancy; and the latter 2 prenatal factors were totally me-
RISK FACTORS FOR SYMPTOM DIRECTIONALITY

The results for symptom directionality were quite simple. Only 5 (9%) of the 56 factors were identified (step 2) as risk factors. The within-time analyses (step 3) showed that there were no proxy risk factors, and the only overlapping risk factors were the maternal report and observed measures of child withdrawal-related negativity in preschool, which were combined. The results of the across-time analyses (step 4) are shown in Figure 5. All 4 final risk factors were associated with a preponderance of internalizing vs externalizing symptoms ($R^2=0.22$). Child sex (high score, girls) was partially mediated by child prosocial behaviors during the school transition. Child withdrawal-related negativity in preschool was partially mediated by child social inhibition during the school transition.

This is an exploratory study intended to generate hypotheses to be tested in future longitudinal studies of this and other populations of children about the paths leading to the severity and directionality of third-grade mental health symptoms. Of the multitude of risk factors in the literature, represented herein by 56 potential risk factors, few constructs are identified in the model as risk factors for symptom severity. This might be because many previously reported factors are not reproducible, and those that are reproducible are often proxy or overlapping to others, as illustrated herein.

The results generate the hypothesis that family SES defines different pathways to children's later symptom severity (ie, it is a moderator). Previous studies have...
shown associations of SES, child or contextual factors, and mental health outcomes.\textsuperscript{9-36} The approach illustrated herein, however, identified distinct mediational chains for lower and higher SES subgroups that include child and contextual risk factors during multiple developmental periods, resulting in models with considerably greater explanatory power ($R^2$) than is typically shown in risk studies. Consistent with developmental theory,\textsuperscript{3-8} the results suggest that being born into a low/middle SES family sets up early experiences, predominantly involving exposure to chronic maternal distress beginning in infancy, which in turn sets up a developmental pathway for the child beginning with higher levels of behavioral dysregulation in preschool and subsequent social and academic impairments during the transition to primary school, all of which increase children’s chances of developing more severe symptoms by third grade. On the other hand, being born into a high SES family may be protective (as shown by mean differences in the symptom severity levels of the 2 SES subgroups) but also defines a different mediational chain beginning prenatally with parental and family histories of psychopathology, which are often regarded as genetic risk indicators that would identify a subset of particularly vulnerable children.\textsuperscript{69-72} Consistent with developmental theory of the transmission of risk among children of depressed mothers,\textsuperscript{6} the results suggest that these family history variables are associated with a more generalized family distress after the child’s birth, which is, in turn, associated with higher levels of behavioral dysregulation in preschool, subsequent social and academic impairments during the transition to primary school, and by third grade, more severe mental health symptoms.

The results also contribute to the 2 large literatures on internalizing problems and associations with child temperament\textsuperscript{9,73,74} and sex\textsuperscript{12,75,76} by generating the hypothesis that these risk factors define distinct pathways to the internalizing vs externalizing nature of children’s later symptoms. One pathway to a preponderance of internalizing symptoms begins with temperamentally inhibited preschoolers who, when faced with the social challenges inherent in the transition to primary school, exhibit socially reticent, withdrawn, and anxious behaviors associated with the development of internalizing disorders. The second pathway is defined by girls who express more prosocial behaviors than boys during the school transition, suggesting that symptom directionality is partly the product of biological sex and socially constrained gender roles. Importantly, the distinction of symptom severity and directionality clarifies some of the ambiguities in studies that have focused on internalizing or externalizing problems. The fact that only child temperament and sex were found to be major risk factors for symptom directionality supports our earlier contention that the risk factors for childhood internalizing and externalizing problems may be much the same. These 2 broad-band problem domains are highly comorbid during childhood and, thus, finding common risk factors is expected. However, more specific risk factors might be identified later in childhood and adolescence when comorbid symptom patterns tend to crystallize into distinct psychiatric disorders.

The results have 2 major implications for prevention and treatment strategies. First, if some of the risk factors for symptom severity are eventually demonstrated to be causal, preventive interventions focused on those factors might prevent or reduce both internalizing and externalizing problems. To show that some of the risk factors are causal, preventive interventions ideally would be directed to those identified at high risk. The interventions would affect the risk factor in a random subset of high-risk children, who would be compared with control subjects to demonstrate whether the risk factor is causal.

Second, based on the explanatory power (multivariate coefficient of determination [$R^2$]) of the models of symptom severity, it appears that children at risk in the high SES subgroup may be identifiable during infancy, while those at risk in the low/middle SES subgroup may be identifiable only later during preschool. Furthermore, social and academic impairment during the school transition may be prodromal expressions of subsequent symptoms. Similarly, for symptom directionality, social inhibition during the school transition may be a prodromal expression of subsequent internalizing symptoms. This suggests that the school transition period may be too late for effective preventive interventions. Even so, interventions targeted at these child factors might prevent the emergence of later symptoms.

It is important to note that what one learns in exploratory data analysis is determined by the outcome measure and the criteria set for the analysis. If our choices were changed, the results might be different. We chose to use a dimensional rather than categorical outcome measure. It has long been known that dichotomizing dimensional outcomes entails a major reduction of power and precision.\textsuperscript{77-80} Eventually, when the risk factors are to be used to identify high-risk subjects, optimal dichotomization must be sought. However, for exploratory data analysis, dimensional measures are more sensitive to individual differences and more likely to detect true structural relationships.

A related issue is the long-standing concern about the difficulty of detecting moderators.\textsuperscript{81-83} However, finding a moderator, such as SES, seems to be a double-edged sword. On the one hand, the presence of moderators would explain the low potency of risk factors found in many studies and the failure to understand who needs intervention, when, and how. On the other hand, detecting a moderator requires splitting the sample, which decreases power to detect risk factors and especially interactions between risk factors, thereby impairing efforts to design appropriate interventions.

There are 2 important limitations of this study. First, the possibility of a sampling bias within this population, and the nonrepresentativeness of this population of the larger US population, must be kept in mind when interpreting the findings. This sample represents largely middle-class, white, and—at the outset—intact families in 2 Midwestern cities. Nevertheless, even here, the SES gradient is of major importance. Furthermore, this is a population in which it would be expected that potent risk factors for childhood psychiatric symptoms would be particularly hard to find. Consequently, to try such exploratory approaches, this is an ideal population to study.
However, we emphasize that the implications of the findings for other populations (eg, higher risk and lower income) are unclear. Thus, it is our hope that the hypotheses generated herein will stimulate the hypothesis-testing studies in other populations that are critical for the development of effective prevention and treatment strategies for childhood mental health problems. Second, as with all studies, the results are limited by the measures available. The measures used may not always be optimal (eg, the assessment of child and parental mental health based on rating scales), and there are undoubtedly other risk factors not measured.

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