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ARTICLE

Development and Prediction of Hyperactive Symptoms From 2 to 7 Years in a Population-Based Sample

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ABSTRACT

OBJECTIVES. Children with hyperactive symptoms are often referred to mental health services. Given the frequency and persistent nature of hyperactivity, it is important to better understand its developmental course. This study identified the different developmental trajectories of hyperactive symptoms from 2 to 7 years and tested early predictors of high-level and persistent hyperactivity. These data may lead to earlier detection of at-risk children and to more effective interventions that take into account developmental considerations.

PARTICIPANTS. Four data-collection cycles of a nationwide survey of Canadian children were used to track the early development of hyperactivity. Children were 0 to 23 months at the first cycle in 1994 and 6 to 7 years at the fourth cycle in 2000.

OUTCOME MEASURES. Hyperactivity data were gathered from mothers on a biennial basis beginning when children were 24 months old. Information on potential prenatal and postnatal predictors was gathered from mothers at the first cycle.

DESIGN. Group-based semiparametric mixture modeling was used to estimate developmental trajectories, and logistic-regression analysis identified predictors of hyperactivity.

RESULTS. Four trajectories of hyperactive symptoms were identified: very low, low, moderate, and high. Statistically significant predictors for high and persistent hyperactivity, after controlling for all other factors, were maternal prenatal smoking, child male gender, maternal depression, and hostile parenting.

CONCLUSIONS. For the majority of children, the frequency of hyperactive symptoms decreased or remained low from 2 to 7 years. However, 7 children in 100 were classified as having high initial levels of hyperactive symptoms that persisted over time. Several prenatal and early postnatal risk factors identified these children, although additional variables will need to be identified to accurately predict high and persistent hyperactivity. Findings suggest that preventive interventions could target high-risk families during pregnancy and early childhood.

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Key Words
developmental, early childhood, hyperactivity, predictors

Abbreviations
ADHD—attention-deficit/hyperactivity disorder
NLSCY—National Longitudinal Survey of Children and Youth
OR—odds ratio

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CHILDREN WHO EXHIBIT hyperactive symptoms are often referred for mental health services because of problems functioning at school, at home, and with peers. Because hyperactivity is a frequent childhood behavior problem of chronic duration, it is important to better understand its developmental course. A longitudinal study of 1000 at-risk boys found that 6% scored high on teacher-reported hyperactivity at 6 years old, and these boys continued to score high over time until midadolescence. The remaining boys exhibited either very low levels of hyperactivity or moderate to high levels that decreased over time.[1] This type of information is important for distinguishing normative from problematic levels of hyperactivity and, more specifically, persistent problematic hyperactivity levels. Unfortunately, longitudinal studies on hyperactive symptoms during early childhood are limited. A recent review identified only 6 studies on hyperactivity during the preschool period, with all of the studies using a cross-sectional design and only 1 of the studies using data from a national sample.[2] The first objective of the study, therefore, was to model the early development of hyperactive symptoms in a national population sample of children from 2 to 7 years of age. Studying early development means that effective interventions for high and chronic hyperactivity can be introduced at a young age and that they can be better tailored to meet developmental changes over time.[3]

The second study objective was to examine early predictors of high-level hyperactive symptoms as a way to better target prevention and intervention efforts. Past studies have identified a number of predictors of hyperactivity and, more specifically, attention-deficit/hyperactivity disorder (ADHD), including family history of ADHD, negative parenting behaviors, maternal depression, childhood oppositional/aggressive symptoms, and childhood difficult temperament.[4–6] These studies, however, have tended to focus on boys or older children or have relied on nonrepresentative samples of children. Moreover, few studies have focused on early predictors that occur during pregnancy or early infancy. A review of pregnancy lifestyle habits indicated that maternal prenatal smoking and drinking generally increased the risk of hyperactivity in children and adolescents.[7] However, only a few of the reviewed studies were based on national samples. A more recent study found that maternal prenatal smoking remained a significant predictor of childhood hyperactivity after controlling for genetic influences, social adversity, child low birth weight, and child comorbid conduct disorder.[8] The study, however, was limited by its cross-sectional design. Our study tested child (eg, temperament) and maternal (eg, depression) characteristics present at birth, as well as postnatal factors (eg, parenting behaviors) before the child's second birthday. We included a number of variables of practical importance that could be modified or prevented.

METHODS

Sample and Procedure

The National Longitudinal Survey of Children and Youth (NLSCY) is a household survey of which the primary objective is to develop a national database on Canadian children's life experiences from infancy into adulthood by covering a 10-year period over 5 biennial data-collection cycles. We currently have access to 4 data-collection cycles (1994, 1996, 1998, and 2000). In cycle 1, 22 831 children aged 0 to 11 years from 13 439 households participated in the survey, with an overall response rate of 86.3%.[9] One child between 0 and 11 years was randomly selected to participate, with a maximum of 4 children per household. The households were selected from the Statistics Canada Labor Force Survey, which uses a stratified, multistage probability sample design to conduct monthly surveys of ~59 000 Canadian households that are representative of the population of Canada. The NLSCY excluded children living in institutional facilities (~0.5% of 0- to 11-year-old children), on Aboriginal reserves, and in the 2 Canadian territories, because they are not targeted by the Labor Force Survey. NLSCY budgetary constraints and attrition have led to loss of data over time. For example, cycle 2 eliminated certain cycle 1 responding households and reduced the maximum number of children surveyed per household from 4 to 2. In the end, there was a high overall response rate (91.6%), which resulted in a responding sample of 15 468 children ages 2 to 13 years from 10 261 households.[10] The NLSCY includes both cross-sectional and longitudinal weights to adjust for possible bias resulting from attrition and to maintain sample representation.

At cycle 1, information was collected from the person most knowledgeable about the child (ie, biological mother in ~90% of cases). Mothers participated in a personal home interview with a trained interviewer. Data also were collected from older children and from teachers of school-aged children.[9] We selected children 0 to 23 months of age at cycle 1 because of our interest in the early to middle childhood developmental period. By cycle 4, children were 7 years old (ie, ≤95 months of age). Children were also required to have complete hyperactivity data for ≥2 of the data cycles to ensure reliable estimation of developmental trajectories (only 1.5% were eliminated because of incomplete data), resulting in a sample of 2946 children. Table 1 shows that children were evenly distributed across gender and age group, and the majority of children (88.5%) were of white ethnicity. Slightly >1 in 10 mothers (11.2%) had their first child at <20 years of age, and 2.7% were <20 years at the birth of the study child. Approximately 1 in 5 mothers (20.7%) and fathers (22.5%) did not com-

TABLE 1 **Sample Description at the First NLSCY Data-Collection Cycle (1994)**

Variable	%
Age of child, mo	
0–11	47.3
12–23	52.7
Gender of child	
Female	49.0
Male	51.0
Ethnicity	
White	88.5
Black	2.1
Asian	6.4
Other	3.0
Age group of mother at birth of first child, y	
14–19	11.2
20–25	35.1
≥26	53.7
Age group of mother at birth of study child, y	
14–19	2.7
20–25	21.3
≥26	76.0
Mother high school education	
Yes	79.3
No	20.7
Father high school education	
Yes	77.5
No	22.5
Mother employed outside the home	
Yes	78.9
No	21.1
Father employed outside the home	
Yes	91.7
No	8.3
Family status at time of interview	
2 parents	88.8
1 parent	11.2
No. of siblings in the home	
0	41.3
≥1	58.7
Ratio of household income to low-income cutoff	
<1	16.6
≥1	83.4

Frequencies are based on data that incorporated the NLSCY cross-sectional weights.

plete high school, and 1 (21.1%) in 4 mothers and 1 (8.3%) in 10 fathers were unemployed. Approximately 1 (11.2%) in 10 children were living in a single-parent household where other siblings were present (58.7%). Close to 17% of households in our sample were substantially worse off than the average Canadian household, as defined by the low-income cutoff, which estimates the minimum income required by a family to meet its basic needs for food, shelter, and clothing. Different cutoffs are established according to family size and the size of the community in which the family lives. Given the stratified, multistage probability sampling strategy of the NLSCY, it should be noted that these sample demographics are representative of Canadian families with children aged 0 to 23 months in 1994.

Measures

Predictor Variables

Socioeconomic and Family Background Information

At cycle 1, mothers responded to interview questions about age at the birth of their first child, age at the birth of additional children, family status and composition, educational level, employment status, and household income. Mothers also provided information on the education and employment of their spouse.

Maternal Depression

At cycle 1, mothers provided information on current symptoms of depression (ie, over the past week) by rating 12 items from the Center for Epidemiologic Studies Depression Scale[11] along a 4-point scale from 1 (rarely or none of the time; <1 day) to 4 (most or all of the time; 5–7 days). Higher scores indicated greater depressive symptoms. The Cronbach α reliability was .82 for 0- to 11-year-old children at cycle 1.

Perinatal Information

At cycle 1, mothers provided information on tobacco and alcohol use during pregnancy. They also answered questions about the infant's status (eg, birth weight). We focused exclusively on the presence/absence of prenatal smoking and drinking (and not on frequency and timing during pregnancy), because findings suggest, for example, that the majority of pregnant smokers continue to smoke throughout their pregnancy.[12,13]

Parenting Practices

At cycle 1, mothers rated 7 items from the Parent Practices Scale[14] along a 5-point scale from 0 (never) to 4 (many times each day). The measure yields 2 types of parenting practices, namely positive interaction (5 items with a Cronbach α reliability of .73 for 0- to 23-month-old children at cycle 1) and hostility (2 items with a Cronbach α reliability of .40 for 0- to 23-month-old children at cycle 1). Higher scores indicated greater use of the parenting practice. Sample positive interaction items include, "How often do you do something special with the child that he/she enjoys?" and "How often do you and your child talk or play with each other, focusing attention on each other for five minutes or more, just for fun?" Sample hostility items include, "How often do you get annoyed with your child for saying or doing something that he/she is not supposed to do?" and "How often do you tell your child that he/she is bad or not as good as others?"

Family Dysfunction

At cycle 1, mothers rated 12 items from the McMaster Family Assessment Device[15] along a 4-point scale from 0 (strongly agree) to 3 (strongly disagree). Higher scores indicated greater family dysfunction. The Cronbach α reliability was .88 for 0- to 11-year-old children at cycle 1. Sample items include, "We express feelings to each

other" and "We are able to make decisions about how to solve problems."

Child Temperament

At cycle 1, mothers rated 7 items from the Infant Characteristics Questionnaire[16] along a 7-point scale from 1 (very little; very easy) to 7 (a lot; very difficult). Higher scores indicated a more difficult temperament. The Cronbach α reliability was .77 for 0- to 11-month-old children and .79 for 12- to 23-month-old children at cycle 1. Sample items include, "How much does your child cry and fuss in general?" and "How easy or difficult is it for you to calm or soothe your child when he or she is upset?"

Child Outcome Variable

Hyperactive Symptoms

The items on hyperactive symptoms were adapted from the widely used Child Behavior Checklist[17] and have been used in 2 Canadian longitudinal studies.[18,19] At each data-collection cycle, mothers rated hyperactive symptoms along a 3-point scale from 0 (never or not true) to 2 (often or very true). Note that mothers did not rate the amount of impairment arising from these symptoms. Child behavior assessments began at 24 months of age, so data in our study were only available for cycles 2, 3, and 4 (because children were 0–23 months at cycle 1). The 3 hyperactivity items were, "Can't sit still, is restless, or hyperactive"; "Has difficulty awaiting turn in games or groups"; and "Cannot settle to anything for more than a few moments." Higher scores indicated greater hyperactive symptoms. The Cronbach α reliability coefficient was .80 for 24- to 35-month-old children and .84 for 4- to 11-year-old children at cycle 1.

Statistical Analyses

The first step was to identify distinctive groups of developmental trajectories for hyperactive symptoms in children from ages 24 to 95 months (ie, 2–7 years, corresponding with NLSCY cycles 2–4). To estimate the trajectories, we used an accelerated longitudinal design with 2 age cohorts, specifically children who, at cycle 1, were between 0 and 11 months and 12 and 23 months. We also grouped the ages in 3-month intervals (eg, 24–26, 27–29, 30–32, etc). The Appendix illustrates the accelerated longitudinal design by cohort over time. By combining the data from the 2 different age cohorts (each of which covers only a segment of the total time period of interest), we are able to study the progression of hyperactive symptoms over the entire developmental period from 24 to 95 months. Note that this design does not impact on the predictor variables, which were collected at cycle 1 for the entire sample of 2946 children aged 0 to 23 months.

We focused on hyperactivity because the *DSM-IV*[20] distinguishes between symptoms that are predominantly hyperactive or inattentive in nature. Furthermore, few studies have examined these symptoms separately despite findings that prevalence rates differ and that there are gender and age differences.[21–24] We estimated trajectories using a semiparametric group mixture model.[25] Models essentially define the shape of trajectories (ie, ascending, descending, or stable), estimate the proportion of the population belonging to each trajectory group, estimate the probability of each child belonging to each trajectory group (ie, posterior probabilities of group membership), and assign the child to the group for which he/she has the largest posterior probability. We estimated models with 2 to 5 trajectory groups and relied on the Bayesian Information Criterion for model selection. All of the analyses included longitudinal sampling weights provided by Statistics Canada to adjust for possible nonresponse bias.

The second step was to use logistic regressions to identify predictors of children in the high hyperactivity group compared with those who did not exhibit high levels of hyperactive symptoms. Note again that data on the predictors were derived from cycle 1 of the NLSCY. The first regression model focused on variables present before or at the birth of the child, and the second added postnatal parenting and family functioning variables. In addition to the NLSCY longitudinal weights, we also incorporated additional weighting procedures using the posterior probabilities of group membership from the trajectory analyses. This was done to take into account the ambiguity that can exist in assigning children to the different trajectory groups. All of the predictor variables were categorized as follows: maternal age was coded as 14 to 19 years, 20 to 25 years, and ≥26 years; maternal depression was scored using established clinical cutoffs[11,26]; and parenting practices, family dysfunction, and child temperament were scored using cutoffs of 1 SD above or below the mean score for our sample. Table 2 indicates that 14.6% of mothers in the sample reported experiencing depression. Approximately 1 (22.7%) in 5 mothers reported smoking while pregnant, and close to 1 (17.7%) in 5 reported prenatal drinking. Low mother-child positive interaction was reported by 13.9% of mothers, and 14.3% reported high hostile interactions with their child. Close to 1 (17.7%) in 5 mothers indicated high family dysfunction. Low birth weight characterized 6.2% of our sample, and 12.8% of mothers reported a difficult temperament in their child.

RESULTS

Developmental Trajectories of Hyperactive Symptoms

The best-fitting model, based on the Bayesian information criterion index, identified 4 trajectories of hyperactive symptoms (Fig 1). A small proportion of the children (4.5%; $n = 132$) exhibited very few initial hyperactive symptoms that decreased to 0 over time. A substantial proportion of the children (42.0%; $n = 1237$) also ex-

TABLE 2 **Frequencies of Predictor Variables From the First NLSCY Data Collection Cycle (1994)**

Variable	%
Maternal depression[a]	
No	85.4
Yes	14.6
Maternal prenatal smoking	
No	77.3
Yes	22.7
Maternal prenatal drinking	
No	82.3
Yes	17.7
Positive interaction parenting practice[b]	
Low	13.9
Not low	86.1
Hostile parenting practice[c]	
Not high	85.7
High	14.3
Family dysfunction[d]	
Not high	82.3
High	17.7
Child birth weight	
Low (<2500 g)	6.2
Not low (>2500 g)	93.8
Child temperament[e]	
Not difficult	87.2
Difficult	12.8

Frequencies are based on data that incorporated the NLSCY cross-sectional weights.
[a] Items were scaled along a 10-point scale, and a cutoff of 2.5 was used to classify mothers as nondepressed (score <2.5) or depressed (score of ≥2.5).
Scores that were >1 SD below the mean were classified as [b] low positive interaction; scores that were >1 SD above the mean were classified as [c] high hostility; [d] high family dysfunction; and [e] difficult temperament.

hibited very few initial hyperactive symptoms, but this low level remained stable over time. An equally substantial proportion of the children (46.3%; $n = 1365$) exhibited moderate initial levels of hyperactivity that declined slightly over time. Finally, 7.2% of the children ($n = 212$) exhibited high initial levels of hyperactivity that increased slightly over time.

Predictors of Hyperactive Trajectories

Before conducting the logistic regression, we calculated the simple bivariate correlations among all of the predictor variables (Table 3). There were a number of statistically significant associations, especially for certain family background characteristics (eg, maternal age, parental education, and parental employment), prenatal smoking, maternal depression, family dysfunction, and parenting practices. Given the number of statistically significant correlations, regression analyses controlled for the effects of all other variables included in the models.

For the logistic-regression analysis, we dichotomized the outcome variable by combining children on the very low, low, and moderate trajectories to form the reference group of normative hyperactive symptoms. Children on the high trajectory (7.2%) formed our group of high and persistent hyperactive symptoms. The first logistic-regression model examined predictors of hyperactive symptoms that were present at or before the birth of the child, while controlling for all of the other variables in the model (see Table 4). The largest risk factor was maternal prenatal smoking. Children whose mothers smoked while pregnant were >2.5 times (odds ratio [OR]: 2.81) more likely to have high and persistent hyperactive symptoms compared with children whose mothers did not smoke during pregnancy. Maternal depression increased the risk of high and persistent hyperactivity by twofold (OR: 2.28). Boys were 2 times more likely than girls to be in the high and persistent hyperactivity trajectory group (OR: 2.20). In the second regression model, we added parenting and family functioning variables measured before the child's second birthday. Findings showed that children whose mothers reported using hostile parenting practices were 2 times more likely to have high and persistent hyperactive symptoms compared with children whose mothers were not hostile (OR: 2.07). Child's gender, maternal prenatal smoking, and maternal depression remained significant risk factors. In sum, 3 early and easily measured variables (prenatal smoking, maternal depression, and hostile parenting) significantly increased the risk of high-level persistent hyperactivity.

Additional analyses indicated that 67% of children who scored positive on ≥1 of these 3 risk factors were in the high and persistent hyperactivity trajectory group. This sensitivity rating suggests that high-level persistent hyperactivity in children would be accurately identified 2 of 3 times with a scale composed of prenatal smoking, maternal depression, and hostile parenting. The positive predictive value of such a scale, however, was low (11%). This finding suggests that a scale composed only of prenatal smoking, maternal depression, and hostile parenting would not have much predictive use, because it would result in a large number of false positives (ie, children being wrongly labeled as exhibiting high and persistent hyperactive symptoms).

DISCUSSION

This study used longitudinal data from a national sample to identify developmental trajectories of hyperactive symptoms from 2 to 7 years of age and the predictors of a high-level and persistent trajectory during that period. Four hyperactivity trajectories were identified: very low (4.5%), low (42.0%), moderate (46.4%), and high (7.2%). For the majority of children, the frequency of hyperactive symptoms decreased or remained low from 2 to 7 years. However, ~7 children in 100 were classified as having high initial levels of hyperactive symptoms that persisted over time. Children with these atypical levels of hyperactivity could be those that meet diagnostic criteria for ADHD given previous research showing that behavior problems, in particular at high levels, are stable from early to late childhood.[27–29] In any case, the findings

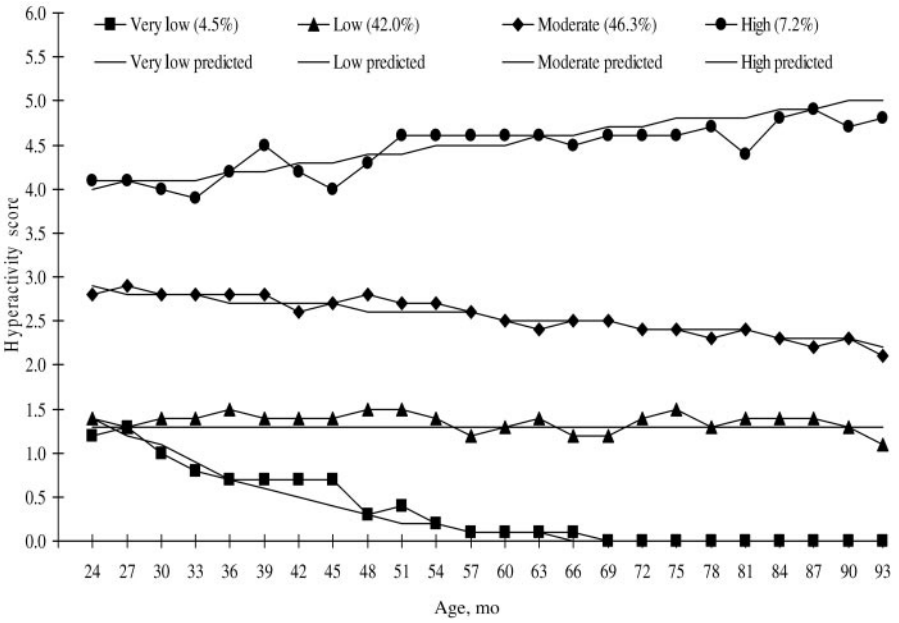

FIGURE 1
Developmental trajectories of hyperactive symptoms in 2- to 7-year-old children. ■ indicates very low (4.5%), accompanying line, very low predicted; ▲, low (42.0%), accompanying line, low predicted; ◆, moderate (46.3%), accompanying line, moderate predicted; ●, high (7.2%), accompanying line, high predicted.

TABLE 3 **Correlations Among Predictor Variables**

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Child age	1.00																	
2. Child gender	3.46	1.00																
3. Child birth weight	5.16	3.26	1.00															
4. Child temperament	52.66[a]	7.33[a]	4.23[a]	1.00														
5. Family status	6.42	0.00	2.66	3.13	1.00													
6. Mother age at first birth	23.10[a]	2.39	2.85	0.39	248.34[a]	1.00												
7. Mother age at target child birth	12.01	0.22	1.44	0.14	408.08[a]	1386.29[a]	1.00											
8. Mother education level	3.74	0.99	2.67	0.86	168.25[a]	367.72[a]	233.73[a]	1.00										
9. Father education level	7.05	5.36[a]	28.92[a]	0.33	3.13	99.32[a]	17.66[a]	346.10[a]	1.00									
10. Mother employed	87.70[a]	2.37	2.78	0.79	12.68[a]	12.73[a]	20.15[a]	4.35[a]	36.22[a]	1.00								
11. Father employed	4.35	0.50	5.49[a]	0.00	1.04	21.75[a]	20.34[a]	14.12[a]	33.31[a]	2.49	1.00							
12. Siblings in the home	8.72[a]	0.63	1.14	3.50	33.38[a]	42.71[a]	163.67[a]	0.09	0.78	0.18	0.00	1.00						
13. Household income	8.65[a]	3.09	0.94	1.87	551.30[a]	325.13[a]	155.77[a]	240.51[a]	96.65[a]	21.47[a]	121.55[a]	4.65[a]	1.00					
14. Mother prenatal smoking	8.98[a]	0.00	0.18	1.61	114.42[a]	97.94[a]	45.34[a]	175.12[a]	58.64[a]	1.06	5.18	0.00	48.25[a]	1.00				
15. Mother prenatal drinking	6.47	7.76[a]	4.56[a]	0.09	0.08	10.45[a]	8.16[a]	10.45[a]	2.73	5.32[a]	3.65	0.01	3.12	22.60[a]	1.00			
16. Mother depression	3.42	5.28[a]	3.43	60.23[a]	66.80[a]	47.36[a]	32.96[a]	34.44[a]	5.64[a]	28.84[a]	1.06	0.29	57.97[a]	21.23[a]	0.74	1.00		
17. Family dysfunction	4.59	3.71	1.52	49.79[a]	91.26[a]	39.21[a]	23.12[a]	30.07[a]	33.57[a]	11.15[a]	14.98[a]	4.42[a]	57.97[a]	9.69[a]	4.72[a]	223.98[a]	1.00	
18. Positive interaction parenting	59.13[a]	1.78	68.54[a]	0.00	0.91	15.09[a]	3.79	38.76[a]	32.70[a]	0.04	3.59	52.90[a]	4.27[a]	0.12	0.24	1.13	18.31[a]	1.00
19. Hostile parenting	202.46[a]	0.72	0.37	92.80[a]	0.04	10.06[a]	3.53	0.00	0.51	1.25	8.11[a]	40.53[a]	5.65[a]	5.14[a]	1.56	25.92[a]	9.44[a]	2.13

[a] Pearson χ^2 correlations are statistically significant ($P < .05$).

suggest that as early as 2 years of age, there is a small proportion of children that could be targeted for interventions that help them (and their parents) better manage problematic symptoms that could escalate over time.

The study also tested a number of potential predictors of hyperactivity present early in the child's life. There were 3 significant predictors: maternal prenatal smoking, maternal depression, and maternal hostile parenting. Smoking during pregnancy increased children's risk for high-level and persistent hyperactive symptoms by >2.5 times, after having controlled for a number of other possible risk factors. These results confirm previous studies[7] but also show that the impact of prenatal smoking can be observed in early childhood and increases up to 7 years of age. Several authors have proposed that compounds found in tobacco smoke (especially nicotine) may damage brain structure and/or functioning at critical times during the development of the fetus or that tobacco smoke may alter maternal physiology in such a way that there is a decrease in the flow of oxygen and nutrients and/or an increase in the flow of harmful tobacco smoke components to the fetus.[30,31]

A common finding is the association between maternal depression and children's symptoms. However, only a few studies have focused specifically on hyper-

TABLE 4 **Prenatal and Postnatal Predictors of High and Persistent Hyperactive Symptoms**

Variable	Model 1		Model 2	
	OR	95% CI	OR	95% CI
Child age, mo[a]				
6–11	1.10	0.55–2.22	1.05	0.52–2.12
12–17	1.50	0.75–3.01	1.27	0.62–2.62
18–23	1.14	0.58–2.24	0.77	0.37–1.62
Child gender[b]	2.20[c]	1.37–3.53	2.62[c]	1.59–4.31
Child birth weight[d]	1.10	0.46–2.62	0.96	0.36–2.50
Child temperament[e]	1.60	0.90–2.84	1.33	0.71–2.48
Mother age at birth of first child, y[f]				
14–19	1.03	0.31–3.39	0.93	0.28–3.09
20–25	1.34	0.74–2.44	1.39	0.75–2.58
Mother age at birth of study child, y[f]				
14–19	0.77	0.04–14.17	0.87	0.05–16.03
20–25	1.11	0.54–2.28	1.14	0.54–2.41
Mother high school education[g]	1.23	0.62–2.43	1.35	0.68–2.70
Father high school education[g]	0.70	0.38–1.28	0.72	0.38–1.35
Mother employed outside the home[h]	1.30	0.75–2.23	1.38	0.79–2.40
Father employed outside the home[h]	0.89	0.36–2.18	0.93	0.38–2.31
No. of siblings in the home[i]	0.71	0.44–1.16	0.80	0.48–1.32
Ratio of household income to low-income cutoff[j]	0.74	0.20–2.70	0.74	0.20–2.73
Mother prenatal smoking[k]	2.81[c]	1.70–4.64	2.75[c]	1.63–4.64
Mother prenatal drinking[l]	1.56	0.93–2.62	1.70	1.00–2.89
Mother depression[m]	2.28[c]	1.31–3.98	2.15[c]	1.18–3.92
Family dysfunction[n]			0.98	0.51–1.89
Positive interaction parenting practice[o]			1.09	0.48–2.47
Hostile parenting practice[p]			2.07[c]	1.17–3.69

CI indicates confidence interval. Estimates are adjusted for all other variables included in the model. Family status was not included because of estimation problems when this variable was included with father education and parental employment. However, a regression model including the family status variable (but not father education and parental employment) did not show family status to be a statistically significant predictor. The reference groups are [a] 0 to 5 months; [b] girls; [d] birth weight that is not low; [e] temperament that is not difficult; [f] ≥26 years; [g] high school completion; [h] employed outside the home; [i] no siblings; [j] is ≥1; [k] no prenatal smoking; [l] no prenatal drinking; [m] no maternal depression; [n] family dysfunction that is not high; [o] positive interactions that are not low; and [p] hostility that is not high.

[c] Statistically significant ORs (ie, do not include 1.00 in CI).

activity.[4–6] Children with a depressed mother were >2 times more likely to have high and persistent levels of hyperactive symptoms than children with a nondepressed mother, after having controlled for a number of other potential risk factors. Although there is concern that depressed mothers are biased toward overreporting symptoms in their children, several studies have found evidence against this hypothesis and have shown mothers (regardless of depression status) to be reliable and accurate reporters of their children's symptoms.[32–34] In addition, we did not assess maternal depression and child hyperactivity during the same time period to help guard against this possible confound (ie, maternal depression was assessed 2 years before the maternal assessments of hyperactivity).

Contrary to a number of previous studies that place maternal depression within the context of impaired parenting practices,[5,35–40] we found the impact of maternal depression on children's hyperactivity to be unaffected by negative parenting practices. In other words, negative mother-child interactions and hostile parenting did not seem to mediate the impact of maternal depression on childhood hyperactivity. There is a need for additional longitudinal studies that examine maternal depression specifically in relation to children's hyperactivity. Finally, results showed that mothers' hostile parenting significantly increased children's risk for hyperactivity. Although previous research has linked negative parenting practices to childhood behavior problems, there are virtually no studies that focused specifically on parenting practices and children's hyperactivity.[6] Again, more research is needed on parenting practices specifically in relation to hyperactivity in children.

Contrary to past studies,[4–8] we did not find low birth weight, difficult temperament, or prenatal drinking to be statistically significant predictors of childhood hyperactive symptoms. The prevalence of low birth weight was only 6.2% in our sample, which may have limited the statistical power to detect significant findings. Low statistical power is a plausible explanation, given that low birth weight was not significantly correlated with maternal prenatal smoking, maternal depression, and maternal hostile parenting. Child temperament showed strong statistical associations with child gender, maternal depression, and maternal hostile parenting (all of which were significant predictors of hyperactivity), and so the effects of temperament may have been attenuated by these other variables. A similar explanation might ac-

count for the lack of statistical significance for maternal prenatal drinking, which was significantly correlated with child gender and maternal smoking during pregnancy. These findings also suggest that adding the variables of low birth weight, difficult temperament, and maternal prenatal drinking to a scale composed of prenatal smoking, maternal depression, and hostile parenting might increase the predictive use of identifying children at risk for high and persistent hyperactivity.

IMPLICATIONS AND LIMITATIONS

The most significant contributions of this study are that we show, with a national population sample, that children with high-level and persistent hyperactivity begin exhibiting these symptoms at an early age, and they can be identified through risk factors that exist before their second birthday. The key, therefore, to reducing the risk of hyperactivity is early detection and preventive interventions. The most at-risk children seem to be boys whose mothers smoked while pregnant, were depressed, and used hostile parenting practices. In fact, we found that hyperactive children scored positive on ≥1 of these 3 easily identifiable and amenable factors 2 of 3 times. Therefore, family planning services are needed to inform women about the dangers of smoking during pregnancy and to assist pregnant women to stop smoking. Intervention programs that address mental health problems, such as depression, and that improve parenting practices should be available and readily accessible by members of a community. Although it seems important to introduce such interventions, we also found that these 3 factors alone did not accurately predict hyperactivity, suggesting that they are necessary but not sufficient. Therefore, more research is needed to identify additional factors that, in conjunction with prenatal smoking, maternal depression, and hostile parenting, could be used to develop a scale that predicts early childhood hyperactivity. In terms of interventions for young children who exhibit hyperactive symptoms, a recent study[41] offers pharmacologic and psychosocial guidelines.

CONCLUSIONS

This study is the only national population sample to study the developmental trajectories and risk factors of hyperactive symptoms throughout early childhood and into the early school years. However, there were limitations in this study that we plan to address in future work. We focused exclusively on hyperactivity to better identify predictors of this specific and common childhood behavior problem. Because children with hyperactive symptoms often also have problems of inattention and oppositional behavior, we plan to examine joint developmental trajectories and to identify predictors of these co-occurring developmental problems in children. Our sole reliance on maternal reports could have biased findings. Although the NLSCY has teacher reports of children's symptoms, these assessments only begin on school entry, and our primary focus is to better identify the beginnings of children's behavior problems. Furthermore, there is a problem with numerous missing data (eg, about half of teachers did not answer the symptoms questions at cycle 1). The hostile parenting measure had limited internal reliability. Our decision to use the hostile parenting measure was based on the limited parenting variables available in the NLSCY for children aged 0 to 23 months at the first data-collection cycle. Other than hostility, the only other available parenting variable is positive interaction (which we have also included). However, we acknowledge that results for the hostile parenting measure should be interpreted as preliminary. Finally, some of the children in the study may have been taking medication for their hyperactive behaviors, which could influence the estimation of developmental trajectories and the identification of predictors. We did not assess medication use during the study time period for the cohort of sampled children. However, previous findings from cycle 1 of the NLSCY indicated that the prevalence of methylphenidate use among 2- to 7-year-old girls and boys was low, ranging from 0.09% to 2.25%.[42]

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APPENDIX **The Accelerated Longitudinal Design According to Age Cohort Over Time**

Cohort	Age, mo																														
	24–26	27–29	30–32	33–35	36–38	39–41	42–44	45–47	48–50	51–53	54–56	57–59	60–62	63–65	66–68	69–71	72–74	75–77	78–81	81–83	84–86	87–89	90–92	93–95							
Cohort 1	C2	C2	C2	C2					C3	C3	C3	C3					C4	C4	C4	C4											
Cohort 2					C2	C2	C2	C2					C3	C3	C3	C3					C4	C4	C4	C4							

C2 indicates cycle 2 (1996); C3, cycle 3 (1998); C4, cycle 4 (2000). The NLSCY did not collect data on hyperactive symptoms at cycle 1 when children in the study were aged 0 to 23 months. To estimate developmental trajectories of hyperactive symptoms, we used 3-month intervals to group the children's ages.

TRANSITION FROM MEETING ABSTRACT TO FULL-LENGTH JOURNAL ARTICLE FOR RANDOMIZED CONTROLLED TRIALS

Context: Not all research presented at scientific meetings is subsequently published and, even when it is, there may be inconsistencies between these results and what is ultimately printed. Although late-breaking trials sessions are now integrated into several major scientific meetings and the results are often promptly and prominently communicated, no studies have examined the publication fate and degree of consistency between meeting abstracts or presentations and subsequent full-length article publications for randomized controlled trials (RCTs) presented at these sessions.

Objective: To compare RCT abstracts presented in the late-breaking trials session vs other sessions at a major scientific meeting and subsequent full-length publications. . . .

Conclusions: Late-breaking trials were larger, more likely to be preceded by a design paper, and less likely to report positive results than RCTs presented at other sessions, but discrepancies between the meeting abstract results and subsequent full-length publication results were common even for late-breaking trials.

Toma M, McAlister FA, Bialy L, Adams D, Vandermeer B, Armstrong PW. *JAMA*. 2006;295:1281

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Development and Prediction of Hyperactive Symptoms From 2 to 7 Years in a Population-Based Sample

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