Original Investigation

# Childhood Sleepwalking and Sleep Terrors
## A Longitudinal Study of Prevalence and Familial Aggregation

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**IMPORTANCE** Childhood sleepwalking and sleep terrors are 2 parasomnias with a risk of serious injury for which familial aggregation has been shown.

**OBJECTIVES** To assess the prevalence of sleepwalking and sleep terrors during childhood; to investigate the link between early sleep terrors and sleepwalking later in childhood; and to evaluate the degree of association between parental history of sleepwalking and presence of somnambulism and sleep terrors in children.

**DESIGN, SETTING, AND PARTICIPANTS** Sleep data from a large prospective longitudinal cohort (the Quebec Longitudinal Study of Child Development) of 1940 children born in 1997 and 1998 in the province were studied from March 1999 to March 2011.

**MAIN OUTCOMES AND MEASURES** Prevalence of sleep terrors and sleepwalking was assessed yearly from ages 1½ and 2½ years, respectively, to age 13 years through a questionnaire completed by the mother. Parental history of sleepwalking was also queried.

**RESULTS** The peak of prevalence was observed at 1½ years for sleep terrors (34.4% of children; 95% CI, 32.3%-36.5%) and at age 10 years for sleepwalking (13.4%; 95% CI, 11.3%-15.5%). As many as one-third of the children who had early childhood sleep terrors developed sleepwalking later in childhood. The prevalence of childhood sleepwalking increases with the degree of parental history of sleepwalking: 22.5% (95% CI, 19.2%-25.8%) for children without a parental history of sleepwalking, 47.4% (95% CI, 38.9%-55.9%) for children who had 1 parent with a history of sleepwalking, and 61.5% (95% CI, 42.8%-80.2%) for children whose mother and father had a history of sleepwalking. Moreover, parental history of sleepwalking predicted the incidence of sleep terrors in children as well as the persistent nature of sleep terrors.

**CONCLUSIONS AND RELEVANCE** These findings substantiate the strong familial aggregation for the 2 parasomnias and lend support to the notion that sleepwalking and sleep terrors represent 2 manifestations of the same underlying pathophysiological entity.

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*JAMA Pediatr*. 2015;169(7):653-658. doi:10.1001/jamapediatrics.2015.127
Published online May 4, 2015.

Sleepwalking is a common childhood parasomnia that usually disappears during adolescence. However, it can persist, or appear de novo, in adulthood. In the third edition of the *International Classification of Sleep Disorders*, sleepwalking is defined as "complex behaviors that are usually initiated during partial arousals from slow-wave sleep....The sleepwalking individual is disoriented in time and space, with slow speech, with severely diminished mentation, and blunted response to questions or requests. There is often prominent anterograde and retrograde memory impairment,"[1(p230-231)] but not always.[2] Sleep terrors, an early childhood parasomnia, also consist of partial arousals from slow-wave sleep "often accompanied by a cry or piercing scream, accompanied by autonomic nervous system and behavioral manifestations of intense fear....Sometimes there is prolonged inconsolability associated with a sleep terror."[1(p231)] For most children, these sleep disorders are relatively benign; however, in some cases, there is a high potential for injury, not to mention parental sleep disruption.

These 2 parasomnias share many characteristics. They are generally characterized by relative unresponsiveness to external stimuli as well as mental confusion.[1] Both kinds of episodes arise mainly from slow-wave sleep, and their occurrence is facilitated by the same factors, including sleep deprivation,[3-5] noise,[6,7] fever (temperature, >38.3°C),[8,9] medication,[10] and sleep-related respiratory events.[11,12] Treatment is also the same for the 2 disorders: scheduled awakenings is the recommended approach in children. Consequently, there is reason to believe that these parasomnias represent different phenotypic expressions of the same underlying disorder rather than distinct entities. Another convincing argument in favor of this view is the cosegregation of these parasomnias within families. It was shown (although in a small sample) that about 80% of sleepwalkers and 96% of people with sleep terrors have at least 1 family member affected by sleepwalking, sleep terrors, or both.[13]

The prevalence of sleep terrors during childhood has never been accurately assessed. The estimations reported are variable (from about 1% to 14.7%).[14-17] Some reasons for these varying estimates are that (1) some studies considered only cases for which the sleep terrors caused a functional effect; (2) the definition of a sleep terror was variable among studies; (3) the age range investigated was significantly different among studies, both in width and in targeted ages; (4) some studies were performed in adults[14] or adolescents[15]; and (5) some sample sizes were too small to be conclusive.[16,17] Moreover, studies rarely include children aged 2 years or younger even though sleep terrors were historically thought to begin at 18 months. Although the prevalence of sleep terrors during childhood is not known with precision, it is greater in children of parents with a history of sleep terrors.[13,18]

Furthermore, studies in twins have consistently documented a possible genetic underpinning for these parasomnias. A model-fitting analysis found that early childhood sleep terrors were in large part explained by additive genetic effects.[19] Hublin and colleagues[20] conducted a retrospective study using an adult Finnish population of twins and found a concordance rate 1.5 times higher in monozygotic than in dizygotic pairs for childhood sleepwalking and 5 times higher in monozygotic than in dizygotic pairs for adult sleepwalking. Using the same cohort, Hublin and colleagues[14] also reported a higher polychoric correlation for childhood sleep terrors in monozygotic twins than in dizygotic twins.

Hence, since most studies on the familial aggregation of sleepwalking and sleep terrors were either conducted retrospectively or in a small sample of probands and none was longitudinal in nature, the aims of the present study were to assess the prevalence of sleepwalking and sleep terrors during childhood in a large prospective longitudinal sample of children; assess the probability of developing somnambulism later in childhood for children who had early sleep terrors; and assess the degree of association between parental history of sleepwalking and presence of sleep terrors and somnambulism in children.

### At a Glance

- This large prospective cohort study examines the prevalence of sleep terrors and sleepwalking and association of these with parental history.
- The peak of prevalence was observed at age 1½ years for sleep terrors (34.4%) and at age 10 years for sleepwalking (13.4%).
- As many as one-third of children who had early childhood sleep terrors developed sleepwalking later in childhood.
- The prevalence of childhood sleepwalking increases with parental history of sleepwalking: 22.5% for children without parental history, 47.4% for children with 1 parent with a history of sleepwalking, and 61.5% for children with both parents with a history of sleepwalking.
- These findings point to a strong genetic influence on sleepwalking and, to a lesser degree, sleep terrors.

## Methods

### Participants

This study was conducted from March 1999 to March 2011 as part of the Quebec Longitudinal Study of Child Development. All children were recruited from the Quebec Master Birth Registry managed by the Ministry of Health and Social Services. A randomized, 3-level, stratified survey design was used to study a representative sample of infants who were born in 1997 and 1998 in the province of Quebec, Canada. The 3 levels were geographic regions of Quebec, each region subdivided into areas that were representative of the number of births in the region, and number of children selected per area proportional to the number of births and to the sex ratio of this area. Families who lived in the northern part of the province of Quebec, Inuit territories, and First Nations reserves were excluded for technical reasons. Children with known neurologic conditions were excluded from the cohort. All families received detailed information by mail on the aims and procedures of the research program, and parents signed a consent form before each assessment. The protocol was approved by the Institut de la Statistique du Québec Ethics Committee.

At the inception of the Quebec Longitudinal Study of Child Development (March 1998), 2223 children aged 5 months were

Table 1. Prevalence of Sleep Terrors and Sleepwalking in a Longitudinal and Prospective Sample[a]

| | % (95% CI) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sleep Terrors | | | | Sleepwalking | | | |
| Age, y[b] | No. | Total | Boys | Girls | No. | Total | Boys | Girls |
| 1½ | 1937 | 34.4 (32.3-36.5) | 34.4 (31.4-37.4) | 34.5 (31.5-37.5) | | | | |
| 2½ | 1904 | 20.7 (18.9-22.5) | 21.6 (19.0-24.2) | 19.8 (17.3-22.3) | 1881 | 3.6 (2.8-4.4) | 4.7 (3.4-6.0) | 2.5 (1.5-3.5) |
| 3½ | 1854 | 21.1 (19.2-23.0) | 20.6 (18.1-23.1) | 21.5 (18.9-24.1) | 1852 | 2.6 (1.9-3.3) | 2.8 (1.7-3.9) | 2.4 (1.4-3.4) |
| 5 | 1438 | 13.4 (11.6-15.2) | 13.2 (10.7-15.7) | 13.5 (11.0-16.0) | 1438 | 5.1 (4.0-6.2) | 5.3 (3.7-6.9) | 4.9 (3.3-6.5) |
| 6 | 1306 | 11.6 (9.9-13.3) | 13.2 (10.6-15.8) | 10.0 (7.7-12.3) | 1307 | 8.3 (6.8-9.8) | 10.0 (7.7-12.3) | 6.7 (4.8-8.6) |
| 7 | 1319 | 10.1 (8.5-11.7) | 11.6 (9.1-14.1) | 8.7 (6.6-10.8) | 1320 | 11.1 (9.4-12.8) | 11.3 (8.8-13.8) | 10.8 (8.5-13.1) |
| 8 | 1259 | 8.6 (7.1-10.1) | 9.6 (7.2-12.0) | 7.7 (5.7-9.7) | 1257 | 11.0 (9.3-12.7) | 11.4 (8.8-14.0) | 10.6 (8.3-12.9) |
| 10 | 1048 | 11.4 (9.5-13.3) | 13.3 (10.3-16.3) | 9.6 (7.1-12.1) | 1042 | 13.4 (11.3-15.5) | 14.4 (11.3-17.5) | 12.6 (9.8-15.4) |
| 12 | 1203 | 8.4 (6.8-10.0) | 10.2 (7.8-12.6) | 6.7 (4.7-8.7) | 1204 | 12.7 (10.8-14.6) | 12.5 (9.8-15.2) | 12.9 (10.2-15.6) |
| 13 | 1010 | 5.3 (3.9-6.7) | 5.3 (3.4-7.2) | 5.4 (3.4-7.4) | 1011 | 12.8 (10.7-14.9) | 14.6 (11.5-17.7) | 10.8 (8.1-13.5) |

[a] Weighted data; total number of children varies at each age for both parasomnias, as there was attrition at each evaluation point.

[b] Sleepwalking was evaluated from ages 2½ to 13 years.

included. Throughout the years, some attrition occurred. In all, 1940 children (87.3% of the initial sample) were included at the onset of the present study, but there was attrition at each assessment time point. The majority of the sample was white (92.8%). Black African, Native Amerindian, Arab, and Asian individuals each represented less than 2% of the sample. Moreover, the numbers may vary from one analysis to another because of missing data on specific questions or at certain assessment times or because of the number of missing values allowed in specific analyses.

### Data Collection

The presence of sleep terrors and sleepwalking was assessed yearly from age 1½ years (for sleep terrors) or 2½ years (for sleepwalking) to age 13 years using single questions included in the self-administered questionnaire for the mother of the child. The question for sleep terrors was, "Does your child have night terrors (wakes up suddenly, crying, sometimes drenched in sweat and confused)?" whereas the question assessing sleepwalking was, "Does your child walk in his/her sleep?" Response choices were never, sometimes, often, and always. Since these 2 parasomnias are not necessarily characterized by a daily or even weekly occurrence, a child was considered as showing the parasomnia if the answer was sometimes, often, or always. When the child was 10 years old, the mother also had to report whether she (if she was the biological mother) or the biological father, or both, had a history of sleepwalking during either childhood or adulthood.

### Statistical Analysis

All prevalence data were adjusted through a weighted variable (according to the 3-level survey design) at each time point so that results could be generalized to the target population of the Quebec Longitudinal Study of Child Development. The effect of sex of the children on the prevalence of sleep terrors and sleepwalking was evaluated using univariate logistic regression. Given that no relationship between sex and either sleep terrors or sleepwalking was found, the association between early childhood sleep terrors (between 1½ and 3½ years, the typical period of occurrence of sleep terrors) and sleepwalking later in childhood (from ages 5 to 13 years) was also evaluated using univariate logistic regression without adjusting for sex of the children. For this analysis, data for all 3 time points of early childhood had to be present, but 3 missing data points on sleepwalking were allowed for ages 5 to 13 years.

Univariate logistic regression was also used to evaluate the association between presence of lifetime sleep terrors and somnambulism in children and their parents' history of sleepwalking. In the case of lifetime presence of sleep terrors (ages 1½ to 13 years) or sleepwalking (ages 2½ to 13 years) in children, some missing data were allowed to avoid too much attrition. For sleep terrors, the data at age 1½ years were required (peak of prevalence) and 5 of the other 10 yearly data points were needed to include the participants. Similarly for sleepwalking, 5 of the other 10 yearly data points were needed (from ages 2½ to 13 years), and the presence of the data at age 10 years (peak of prevalence) was ensured by the fact that the question regarding parental history of sleepwalking was asked at that age. Finally, multivariable logistic regressions were used to predict sleep terrors and sleepwalking, adjusting for confounding variables (sex and presence of snoring).

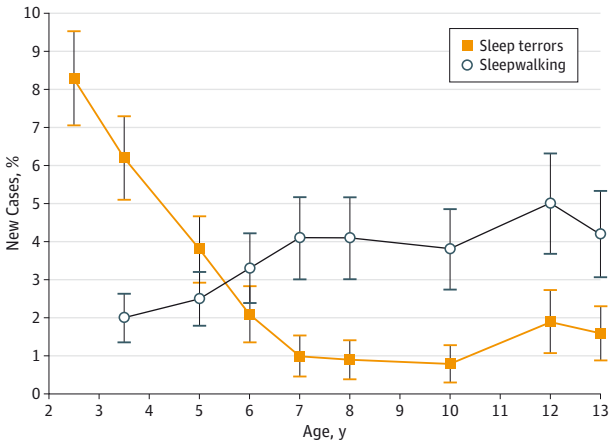
All prevalences and unadjusted and adjusted odds ratios (ORs) are reported with their corresponding 95% CIs. Statistical analyses were conducted using SPSS, version 21 (IBM).

## Results

### Prevalence

The prevalence of sleep terrors (total and by sex) from ages 1½ to 13 years is illustrated in **Table 1**. This large cohort and prospective study reveals a high prevalence for sleep terrors of 34.4% at 1½ years (sleep terrors were not assessed at 5 months). This prevalence rapidly decreased to 13.4% at age 5 years and slowly tapered to 5.3% at age 13 years. Corroborating that sleep terrors are an early childhood parasomnia, few new cases appeared after age 5 years (**Figure**). The overall childhood prevalence of sleep terrors (ages 1½ to 13 years; 1654 children) was

Figure. Onset of New Cases of Sleep Terrors and Sleepwalking as a Function of Age




From the peak prevalence of 34.4% at age 1½ years, the number of new cases of sleep terrors (orange squares) decreased rapidly each year to reach 10% at age 7 years. Conversely, the number of new cases of sleepwalking (open circles) increased steadily until age 12 years. Assessment of sleep terrors begins at age 2½ years and assessment of sleepwalking at 3½ years because the data presented here are the new cases reported after the first assessment time. Error bars represent 95% CIs.

Table 2. Results of Univariate and Multivariable Logistic Regressions to Predict Lifetime Sleep Terrors[a] and Sleepwalking[b]

| | Odds Ratio (95%CI) | |
|---|---|---|
| Predictor | Unadjusted | Adjusted |
| **Sleep Terrors in Childhood** | | |
| Male sex | 1.09 (0.90-1.32) | 1.21 (0.90-1.62) |
| Snoring | 0.80 (0.54-1.20) | 0.66 (0.39-1.23) |
| History of sleepwalking in parents | | |
| 1 parent | 1.43 (0.97-2.10) | 1.42 (0.95-2.11) |
| Both parents | 1.32 (0.58-2.98) | 1.32 (0.58-2.99) |
| None | 1 [Reference] | 1 [Reference] |
| **Sleepwalking in Childhood** | | |
| Male sex | 1.16 (0.93-1.44) | 1.07 (0.76-1.50) |
| Snoring | 1.53 (1.00-2.32) | 1.70 (0.85-3.37) |
| Sleep terrors before age 4 y | 1.94 (1.54-2.45) | 1.83 (1.30-2.58) |
| History of sleepwalking in parents | | |
| 1 parent | 2.80 (1.90-4.13) | 3.02 (2.00-4.56) |
| Both parents | 5.52 (2.45-12.44) | 7.25 (2.98-17.62) |
| None | 1 [Reference] | 1 [Reference] |

[a] Ages 1½ to 13 years.

[b] Ages 2½ to 13 years.

56.2% (95% CI, 53.8%-58.6%). Sex was not associated with the occurrence of sleep terrors during childhood (**Table 2**).

By contrast, sleepwalking was relatively infrequent during the preschool period but increased steadily to reach 13.4% by age 10 years (Table 1). Its prevalence then remained at approximately 13% until age 13 years (12.7% at 12 years and 12.8% at 13 years). The percentage of new cases slowly increased until age 12 years (Figure). The overall childhood prevalence of sleepwalking (ages 2½ to 13; 1524 children) was 29.1% (95% CI, 26.8%-31.4%). In general, sex was not associated with the occurrence of sleepwalking during childhood (Table 2).

## From Sleep Terrors to Sleepwalking

Children who experienced sleep terrors during early childhood (from 1½ to 3½ years; 546 children) were more likely to develop somnambulism later in childhood (≥5 years) than were the children (n = 631) who did not experience sleep terrors in early childhood (34.4% vs 21.7%; OR, 1.89; 95% CI, 1.46-2.45). Among children who had early childhood sleep terrors, 41.7% (95% CI, 37.6%-45.8%) continued to experience them from age 5 years onward. By comparison, only 16.5% (95% CI, 13.6%-19.4%) of children without sleep terrors before age 4 years started experiencing them at age 5 years or older (OR, 3.61; 95% CI, 2.75-4.73). In a more general fashion, the presence of early childhood sleep terrors was associated with childhood sleepwalking (Table 2); children with sleep terrors were almost twice as likely to also experience sleepwalking.

## Association Between Sleep Terrors in Children and Parental History of Sleepwalking

A response on the parental history of sleepwalking was obtained for 1051 mothers and 801 fathers when the children were aged 10 years. There were slightly more parents with a history of sleepwalking in the group of children with sleep terrors compared with children who never had sleep terrors (31.6% [95% CI, 27.4%-35.8%] vs 25.0% [95% CI, 20.6%-29.4%]; OR, 1.39; 95% CI, 1.03-1.88).

Moreover, our data suggest that parental history of sleepwalking was associated with the transient or persistent nature of sleep terrors in children. *Transient* was defined as having sleep terrors before age 4 years and none thereafter, whereas *persistent* meant that children had sleep terrors before age 4 years and still had them after the age of 5 years. Twice as many children with a parental history of sleepwalking had persistent sleep terrors than children without such a parental history (32.0% [95% CI, 23.8%-40.2%] vs 16.8% [95% CI, 12.2%-21.4%]; OR, 2.33; 95% CI, 1.41-3.85).

## Association Between Sleepwalking in Children and Parental History of Sleepwalking

There were more than twice as many parents who had experienced sleepwalking among children who sleepwalked than among children who had never sleepwalked from 2½ to 13 years. Similarly, there were twice as many children who sleepwalked than those who had never sleepwalked who had either a mother or father who sleepwalked. Overall, we found that the odds of sleepwalking in a child increased with the number of parents with a history of sleepwalking (Table 2): children with 1 parent with a history of sleepwalking had 3 times the odds of becoming a sleepwalker, and children with both parents with a history had 7 times the odds (adjusted model) of becoming a sleepwalker compared with children with no parental history of sleepwalking. In prevalence terms, 22.5% (95% CI, 19.2%-25.8%) of children without a parental history of sleepwalking developed sleepwalking, 47.4% (95% CI, 38.9%-55.9%) of children who had 1 parent who was a sleepwalker developed sleepwalking, and 61.5% (95% CI, 42.8%-80.2%) of

children developed sleepwalking when both the mother and father were sleepwalkers.

We also investigated the association between parental history of sleepwalking and age at onset of sleepwalking in children in a subset of 132 sleepwalking children with complete data from ages 2½ to 13 years. There was no difference in age at onset between children of parents with no history of sleepwalking and children of parents with a history of sleepwalking.

Finally, there was no association between the presence of snoring and either sleep terrors (1819 children, measured at peak prevalence) or sleepwalking (916 children, measured at peak prevalence).

## Discussion

Although sleep terrors are known to occur during early childhood, their prevalence had never been estimated with precision or during the entire period of childhood. We found a high prevalence (almost 35%) for sleep terrors (at least occasionally) at 1½ years, with a progressive decline thereafter. A similar prevalence (36.9%) was found in 390 pairs of 18-month-old twins,[19] which also declined to approximately 20% at 30 months. In our study, the overall prevalence during the entire childhood (1½ to 13 years) was even greater at approximately 56%. However, in both studies, the presence or absence of sleep terrors at each time point was derived from the mother's responses on a self-administered questionnaire. Consequently, both the overall and age-specific prevalences of sleep terrors may be overestimated in the current sample, but it is nonetheless considerably higher than what was previously reported.

Our study revealed, in a large prospective and representative sample of children, that the prevalence of sleepwalking is approximately 29% for the entire childhood period (2½ to 13 years) and that it peaks at approximately 13% around ages 10 to 13 years. The only study that investigated childhood somnambulism in a prospective and longitudinal manner (from ages 6 to 16 years), also based on a questionnaire completed by the mother, was conducted in 31 girls and 44 boys with somnambulism from a reference sample with an unknown total number of children.[21] It found a peak prevalence of 16.7% at age 12 years with no sex difference and with a progressive decline to approximately 7.5% at age 16 years. To our knowledge, the evolution of early childhood sleep terrors had never been investigated in a large prospective study. We showed that sleep terrors persist in more than 40% of children after age 5 years and, perhaps more important, that they are associated with sleepwalking later in childhood in one-third of children (with or without concomitant sleep terrors).

Our study also adds to the literature showing that the likelihood of being a sleepwalker as a child is largely associated with parental history (past or present) of sleepwalking. The percentages of children found to experience sleepwalking as a function of the absence or presence of parental history are similar to what was reported by Kales et al[13] on a much smaller sample. With our large cohort, we were able to estimate that children of parents who are or were sleepwalkers are 3 to 7 times more likely to be sleepwalkers themselves depending on whether 1 or both parents had the sleep disorder. In this disorder however, parental history of sleepwalking does not seem to elicit an earlier age of onset in offspring as is observed in other diseases, such as Alzheimer disease[22] or some cancers.[23]

A similar association with parental history for sleep terrors was reported in the literature.[13] Unfortunately, parental history of sleep terrors was not documented in our study. However, we showed that a parental history of sleepwalking can also predict the emergence of sleep terrors in children. These findings lend support to the notion that sleepwalking and sleep terrors represent 2 manifestations of the same underlying pathophysiological condition.

Sleep-disordered breathing can be a triggering factor for sleepwalking[12] and shows familial aggregation.[24] It has been suggested that the genetic predisposition for sleepwalking and sleep terrors could be shared with sleep-disordered breathing.[24] The fact that both childhood parasomnias had a strong association with parental history, while not associated with snoring in the child, suggests that this theory is not the case.

This study has some limitations. The assessment of sleepwalking and sleep terrors was not derived from physicians' diagnoses or from objective sleep laboratory assessments. Our data were obtained from parental reports and, although recognizing sleepwalking is usually not difficult for parents, the identification of sleep terrors can be more problematic. Our questionnaire contained an operational definition for sleep terrors, but it is nevertheless possible that some parents mistook nightmares for sleep terrors and vice versa.

## Conclusions

These findings point to a strong genetic influence on sleepwalking and, to a lesser degree, sleep terrors. This effect may occur through polymorphisms in the genes involved in slow-wave sleep generation or sleep depth.[25-27] Parents who have been sleepwalkers in the past, particularly in cases where both parents have been sleepwalkers, can expect their children to sleepwalk and thus should prepare adequately. Although genetics establish predisposition, there are triggering environmental factors that may be involved as moderators. Preventive measures include avoiding sleep deprivation, irregular sleep schedules, and noisy sleeping environments. In more serious cases, house alarms may be needed to prevent children from leaving the house in their sleep. As stated in the third edition of the *International Classification of Sleep Disorders*, "With the development of sophisticated genetic testing and neuroimaging, direct research into the causes and mechanisms of disorders of arousal is anticipated."[1(p238)]

ARTICLE INFORMATION

**Accepted for Publication:** January 14, 2015.

**Published Online:** May 4, 2015. doi:10.1001/jamapediatrics.2015.127.

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**Author Contributions:** Dr Montplaisir had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
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**Conflict of Interest Disclosures:** Dr Desautels reported receiving research grants from GlaxoSmithKline and Novartis Pharma as well as honoraria from speaking engagements from UCB and Paladin Labs. Dr Montplaisir reported receiving grants or support from Merck and GlaxoSmithKline; serving as an advisor for Sanofi, Servier, Merck, Jazz Pharmaceuticals, Valeant Pharmaceuticals, and Impax Laboratories; and receiving honoraria for speaking engagements from Valeant Pharmaceuticals and Otsuka Pharmaceutical. No other disclosures were reported.

**Funding/Support:** Funding was obtained from Quebec's Department of Health and Social Services; the Canadian Institutes of Health Research; the Social Sciences and Humanities Research Council of Canada; the Quebec Fund for Research on Society and Culture; the Quebec Fund for Research on Nature and Technology; the Health Research Fund of Quebec; Quebec's Ministry of Research, Science and Technology; Human Resources Development Canada; Health Canada; the University of Montreal; Laval University; and McGill University. This funding was obtained throughout the years for the Quebec Longitudinal Study of Child Development as a whole (design and data collection) but not for the specific purpose of the present study.

**Role of the Funder/Sponsor:** The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

**Additional Contributions:** We thank the children and families whose ongoing participation made this study possible. We also acknowledge the considerable contribution of the coordinators of the Quebec Longitudinal Study of Child Development and the Quebec Institute of Statistics. The contributors were not compensated.

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