ORIGINAL ARTICLE

Children's Self-Reported Psychotic Symptoms and Adult Schizophreniform Disorder

A 15-Year Longitudinal Study

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Background: Childhood risk factors for the development of adult schizophrenia have proved to have only modest and nonspecific effects, and most seem unrelated to the adult phenotype. We report the first direct examination of the longitudinal relationship between psychotic symptoms in childhood and adulthood.

Methods: We analyzed prospective data from a birth cohort (N=761), in which children were asked about delusional beliefs and hallucinatory experiences at age 11 years, and then followed up to age 26 years. Structured diagnostic interviews were employed at both ages and self-report of schizophreniform symptoms was augmented by other data sources at age 26 years.

Results: Self-reported psychotic symptoms at age 11 years predicted a very high risk of a schizophreniform diagnosis at age 26 years (odds ratio, 16.4; 95% confidence interval, 3.9-67.8). In terms of attributable risk, 42% of the age-26 schizophreniform cases in the cohort had reported 1 or more psychotic symptoms at age 11 years. Age-11 psychotic symptoms did not predict mania or depression at age 26 years, suggesting specificity of prediction to schizophreniform disorder. The link between child and adult psychotic symptoms was not simply the result of general childhood psychopathology.

Conclusion: These findings provide the first evidence for continuity of psychotic symptoms from childhood to adulthood.

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THE SEARCH for childhood risk factors has played a central role in the quest to uncover the etiologies of schizophrenia and related disorders. Studies examining such risk factors have mainly used retrospective case-control, prospective high-risk, or population-based cohort designs. Retrospective studies are prone to selection and recall bias,[1] and prospective high-risk studies[2-5] tend to evaluate relatively small samples of children, resulting in low statistical power. Over the past decade, the "coming of age" of many birth cohort studies has seen the population-based cohort design gain prominence as the method of choice for investigating childhood risk factors for schizophrenia. Risk factors identified to date include obstetric complications,[6,7] place and time of birth,[8] delayed motor and language development,[9] cognitive risk factors,[9-11] and social-behavioral risk factors.[9,10,12-14]

However, the extant evidence is characterized by 3 limitations. First, most researchers have been constrained to examining available archival information, which was usually collected for other purposes (eg, birth records, home movies, school records), and there are few sources of detailed psychological (as distinct from sociobehavioral) childhood information available. It is important to determine whether continuity of symptoms over the life course can be identified in psychosis, as indeed it has been in depression.[15] Second, studies to date have addressed what percentage of schizophrenic individuals had a risk factor in their histories, but do not address what percentage of children with the risk factor go on to develop schizophrenia. With a notable exception,[13] the effect sizes of the childhood risk factors for schizophrenia identified so far are relatively small (odds ratios [ORs] of about 2),[16] with positive predictive values for sociobehavioral risk factors of between 3% and 5%.[12,17] Third, specificity for schizophrenia has not been established. Many of the childhood risk factors identified for schizophrenia are also associated with affective psychosis and affective disorders, albeit to a lesser degree.[18-20]

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PARTICIPANTS AND METHODS

SAMPLE

Participants were members of the Dunedin Multidisciplinary Health and Development Study, a longitudinal investigation of the health, development, and behavior of a birth cohort born between April 1, 1972, and March 31, 1973, in Dunedin, New Zealand.[25] When the cohort was first traced for follow-up at age 3 years, 91% of the eligible births participated in the assessment, providing a base sample of 1037 (52% were boys). Cohort members represent the full range of socioeconomic status in the general population of New Zealand's South Island, and 85% identify themselves as exclusively New Zealand European. The cohort was assessed at ages 3, 5, 7, 9, 11, 13, 15, 18, 21, and 26 years. We report data from the age-11 (1983-1984) and age-26 assessments (1998-1999).

Analyses linking age-11 symptoms and age-26 schizophreniform outcomes required present psychiatric interview data at both ages. Psychiatric interviews were complete at age 11 years for the 789 cohort members seen at the Dunedin Unit (one quarter of the cohort was assessed at school, and unfortunately did not see the psychiatrist). Psychiatric interviews assessing schizophreniform symptoms were complete at age 26 years for 972 of the 1019 cohort members still living (95% were followed up). Age-26 outcomes were compared between those interviewed at both ages 11 and 26 years and included in this report (N=761) and those who had to be omitted because they were interviewed at age 26 years but not at 11 years (n=211). Those included vs omitted did not differ significantly on their rate of psychiatric diagnosis in general ($\chi^2_1=0.02$, $P=.89$) nor on prevalence of schizophreniform diagnosis ($\chi^2_1=1.7$, $P=.19$). The prevalence of age-26 schizophreniform diagnosis was 3.7% in the full cohort and a comparable 3.3% in the 761 cohort members analyzed here. Thus, study members whose results are described in **Tables 1** and **2** represent the full birth cohort with regard to adult psychiatric outcome.

AGE-11 PREDICTORS

At age 11 years, study members were, for the first time in the Dunedin Study, administered the Diagnostic Interview Schedule for Children (DISC-C)[24] for *DSM-III*[26] by a child psychiatrist.[27] The schizophrenia section of the DISC-C interview asked 5 questions of study members: (1) "Some people believe in mind reading or being psychic. Have other people ever read your mind?"; (2) "Have you ever had messages sent just to you through television or radio?"; (3) "Have you ever thought that people are following you or spying on you?"; (4) "Have you heard voices other people can't hear?"; and (5) "Has something ever gotten inside your body or has your body changed in some strange way?" The fifth question was not endorsed by any study member. The items were scored by the psychiatrist (0, no; 1, yes, likely; and 2, yes, definitely).

The responses to these 4 questions were added. The majority of study members obtained a score of 0 (n=673), 13% obtained a score of 1 (n=103), and the remainder obtained a score of 2 (n=11), 3 (n=1) or 4 (n=1). Given the restricted range of scores the following groups of cases and controls were created: group 1 (no symptoms [controls]) and a score of 0 [n=673; 50.2% were male]); group 2 (weak symptoms and a score of 1 [n=103; 66.0% were male]); and group 3 (strong symptoms and a score of ≥2 [n=13; 61.5% were male]). At minimum, study members could enter the strong symptom group by obtaining a score of 1 (yes, likely) for 2 symptoms, or by obtaining a score of 2 (yes, definitely) for 1 symptom. Two psychiatrists (M.C. and R.M.) and 2 clinical psychologists (R.P. and T.E.M.) reviewed the psychiatrists' notes and concurred that the symptoms seemed genuine in content. The 3 age-11 risk groups (strong symptoms, weak symptoms, and controls) did not differ by parental socioeconomic status[28] ($F_{2,784}=1.1$, $P=.33$) or on the Weschler Intelligence Scale for Children-Revised Full-Scale IQ test ($F_{2,786}=1.67$, $P=.18$).

PSYCHIATRIC STATUS AT AGE 26 YEARS

At age 26 years, symptoms were ascertained using the DIS,[29] administered by health professionals (blind to previous diagnosis) with a master's degree at minimum. The reporting period was 12 months before the interview. Diagnostic procedures, reliability, and validity of the *DSM* diagnoses made in this sample have been reported previously.[30] The 12-month prevalence of mental disorder in the Dunedin sample closely matches the 12-month prevalence for young adult subjects in the US National Comorbidity Survey.[31] The primary outcome for this study was schizophreniform disorder (n=36 [3.7%], 25 of whom had been interviewed by the psychiatrist at age 11 years). This diagnosis incorporated several changes to the *DSM-IV* diagnostic criteria,[32] which were made to enhance diagnostic validity, as detailed below.

SCHIZOPHRENIFORM DIAGNOSIS

Criterion A

Structured psychiatric interviews, such as the DIS, have been criticized for identifying unexpectedly large numbers of cases who endorse psychotic-type experiences and beliefs, some of whom have clinical psychosis, but many of whom do

A compelling childhood risk factor for adult schizophrenia would have the following characteristics: it would bear a moderate-to-strong statistical relationship to later schizophrenic outcomes, it would not falsely identify large numbers of children as at-risk who will never develop schizophrenic symptoms, and it would predict psychoses with specificity instead of posing generalized risk for many other disorders.

In the present study, we investigated whether self-reported delusional beliefs and hallucinatory experiences at age 11 years predicted schizophrenic outcomes 15 years later. Demonstration of such predictive continuity could have important clinical and public health implications. If childhood symptoms of psychosis were shown to foreshadow adult psychoses, early intervention targeting those at greatest risk would be possible. Discovery of sensitive and specific childhood predictors of adult schizophreniform disorders could also open up possibilities for primary prevention. Finally, demonstration of sensitive and specific predictors of schizophreni-

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not.[33-35] Our interview ruled out symptoms with plausible explanations and symptoms occurring solely under the influence of alcohol or drugs or during a major depressive episode. Like other epidemiological studies,[36-38] we initially found that many cases could meet the computerized algorithm for diagnosis (n=131 [13.5%]). This probably occurs because the *DSM-IV* criterion A for schizophrenia can be fulfilled relatively easily with 2 symptom types (or 1 particularly bizarre symptom); it is theoretically possible to fulfill the diagnostic algorithm with, for example, delusions and anhedonia, in the absence of hallucinations. Kendler et al[33] demonstrated that subjects who report delusions but not hallucinations were particularly unlikely to be confirmed as psychotic by a clinician. Therefore, to ensure appropriate case ascertainment and avoid overdiagnosis of psychosis, we required that 1 or more hallucination symptoms as well as at least 2 other symptoms were reported "yes, definitely."

Disorganized speech was rated by a social worker, blind to diagnoses, who greeted study members and shepherded them through the daylong assessment procedures. Three speech items were rated as 0, no; 1, yes, somewhat; and 2, yes, definitely. Study members were categorized as having a speech problem if they were rated 2 on impoverished speech (single word utterances, difficulty expressing ideas) or if they were rated 0 on the items examining whether they were articulate, or easy to understand.

Criterion B

The *DSM-IV* criterion B for schizophreniform disorder requires impairment in 1 or more areas of social or occupational functioning. Because poor insight characterizes many individuals with serious psychotic illness[34,39,40] sole reliance on self-report may result in underdiagnosis. Therefore, we supplemented study members' self-reports with independent informants' ratings to determine levels of social and occupational impairment. Informants mailed in checklists for 96% of the study members (75% of the informants were relatives and 25% close friends). The *DSM-IV* requires 1 or more social or occupational impairments in 3 areas.

OCCUPATIONAL IMPAIRMENT

Long-term unemployment was defined as 6 or more months in the previous 5 years when the study member was unemployed and not enrolled in education or a homemaker, as assessed via the Life History Calendar.[41]

Poor money management skills were assessed via 1 item from the problem checklist mailed in by informants. Money management was assessed on a 3-point scale (0, not a problem; 1, a bit of a problem; and 2, yes, a problem). Those with a score of 1 or 2 were defined as poor money managers.

SOCIAL IMPAIRMENT

Absence of a relationship with a partner was reported by study members in a separate structured interview session about partners, in which it was ascertained whether they had been involved in any relationship in the 12 months before the interview. Paranoia was assessed via the problem checklist mailed in by informants. The 3 items chosen were "thinks others are out to get them," "blames others for own problems," and "suspicious of other people" (0, not a problem; 1, a bit of a problem; and 2, yes, a problem). A problem in at least 1 of these areas was considered evidence of paranoia. Social isolation was assessed using 3 items from the same informant checklist, scored in the same way: "has trouble making friends," "feels that no one loves them," and "seems lonely." Study members with a problem on at least 1 of these 3 items were considered socially isolated.

SELF-CARE

Poor personal grooming was rated on the interview day by the social worker (kept blind to diagnosis). The item "clean, well groomed" was rated on a 3-point scale (0, no; 1, somewhat; and 2, definitely). Those with a score of 0 or 1 were defined as poorly groomed.

An age-26 diagnosis of schizophreniform disorder used in this report required hallucinations and at least 2 other symptom types from criterion A of *DSM-IV*, plus evidence of impairment in at least 1 of the areas of social or occupational functioning described above. The symptoms were present in all 36 cases for at least 1 month (required for a schizophreniform diagnosis) and continuously present in 9 cases for 6 months or longer (required for a schizophrenia diagnosis). In terms of clinical status, 53% of persons meeting this diagnosis received mental health treatment in the past year (from a general practitioner, psychiatrist, emergency department, a rehabilitation clinic, were prescribed psychiatric medications, or were hospitalized), compared with 17% of nondisordered cohort members (OR, 5.6; 95% confidence interval [CI], 2.8-11.2).

STATISTICAL ANALYSIS

Continuity between psychotic symptoms at age 11 years and psychotic symptoms and impairment at age 26 years was evaluated using the Mantel-Haenszel χ^2 test for linear association. Logistic regression equations were used to predict age-26 schizophreniform disorder. The equations contained dummy variables representing both the strong and the weak symptom groups. The contrast or reference group was the control group of children who reported no psychotic symptoms at age 11 years. The ORs and 95% CIs are reported.

form disorders may also prove beneficial to neuroscience researchers by providing a means of identifying and selecting high-risk subjects before their disease has altered the course of their lives and health.[21-23] Because widespread use of standardized structured diagnostic interviews for children only began in the early 1980s,[24] it is only now that samples of children such as ours, who were systematically assessed for psychotic-type symptoms, are reaching the age when adult schizophreniform outcomes can be assessed.

RESULTS

AGE-11 SYMPTOMS AND AGE-26 OUTCOMES

At age 26 years, approximately 1 in 4 study members reported at least 1 delusional or hallucinatory experience that was unrelated to drug use or physical illness (Table 1). On the other hand, there were low rates of study members reporting negative symptoms, such as anhedonia (1.2%). A significant linear trend indicated that, as age-11 symp-

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Table 1. Percentage of Study Members Reporting Schizophrenic Symptoms at Age 26 Years Among the Control, Weak Symptom, and Strong Symptom Groups Defined at Age 11 Years

		Age-11 Group, No. (%)					
	Data Source	Total (N = 761)	Control Group (N = 654)	Weak Symptom Group (n = 95)	Strong Symptom Group (n = 12)*	Value of the Mantel-Haenszel Test for Linear Association (*df* = 1)	Significance Level, *P*
Age-26 Criterion A							
Schizophrenia symptoms							
Delusions	Self	**153** (20.1)	122 (18.7)	26 (27.4)	5 (41.7)	7.24	.007
Hallucinations	Self	**100** (13.2)	74 (11.3)	21 (22.1)	5 (41.7)	16.54	<.001
Disorganized speech	Observer	**137** (17.9)	109 (16.6)	23 (23.7)	5 (41.7)	6.89	.009
Catatonic behavior	Self	**59** (7.8)	45 (6.9)	10 (10.6)	4 (33.3)	8.75	.003
Negative symptoms	Self	**9** (1.2)	6 (0.9)	2 (2.1)	1 (8.3)	4.65	.03
Age-26 Criterion B							
Occupational or social dysfunction							
Occupational							
Long-term unemployment†	Self	**91** (11.9)	71 (10.8)	17 (17.9)	3 (25.0)	5.90	.01
Poor money management	Informant	**137** (18.6)	106 (16.8)	27 (28.7)	4 (36.4)‡	9.90	.002
Social							
Not in a relationship	Self	**200** (26.3)	159 (24.3)	36 (37.9)	5 (41.7)	8.93	.003
Paranoia	Informant	**93** (12.6)	73 (11.6)	17 (18.1)	3 (27.3)‡	5.26	.02
Social isolation	Informant	**76** (10.3)	59 (9.4)	14 (14.9)	3 (27.3)‡	5.80	.02
Poor grooming	Observer	**264** (34.6)	217 (33.1)	40 (41.2)	7 (58.3)	5.21	.02

**The 1 study member who was not located for assessment at age 26 years was socially and occupationally impaired at ages 18 and 21 years and reported the following psychotic symptoms at age 21 years: "Unusual feelings inside or on your body, like being touched when nothing was there or feeling something was moving inside your body" and "Actually hearing what another person was thinking even though they were not speaking, or believing others could hear your thoughts."*

†Unemployment longer than 6 months in the previous 5 years and not enrolled in educational program or a homemaker.

‡Strong symptom group had 11 individuals, as 1 member did not have an informant.

Table 2. Specificity of the Relationship Between Childhood Psychotic Symptom Group and Adult Psychiatric Diagnoses

	Age-11 Group, No. (%)					
Psychiatric Diagnoses at Age 26 Years*	Total Sample (N = 761)	Control Group (n = 654)	Weak Symptom Group (n = 95)	Strong Symptom Group (n = 12)	Value of the Mantel-Haenszel Test for Linear Association (*df* = 1)	Significance Level, *P*
Schizophreniform	**25** (3.3)	13 (2.0)	9 (9.5)	3 (25.0)	31.08	<.001
Mania	**14** (1.8)	13 (2.0)	1 (1.1)	0 (0.0)	0.63	.43
Depression	**119** (15.7)	99 (15.2)	19 (20.0)	1 (8.3)	0.34	.56
Anxiety	**180** (23.7)	144 (22.1)	32 (33.7)	4 (33.3)	6.20	.01

**The Axis I disorders diagnosed at age 26 years were grouped into the following diagnostic families (following groupings found in the* DSM-IV*): manic episodes; depressive disorders, comprising major depressive episode and dysthymia; anxiety disorders, comprising generalized anxiety disorder, panic disorder, agoraphobia, social phobia, obsessive-compulsive disorder, posttraumatic stress disorder, and specific phobia.*

toms increased in strength, so did the percentage of study members at age 26 years who reported both positive and negative symptoms of schizophrenia (criterion A) and occupational or social impairment (criterion B). The strongest linear trend was for age-26 hallucinations.

The schizophreniform diagnosis was overrepresented among children who reported psychotic symptoms at age 11 years: 2% of the control children vs 9.5% and 25% of the weak and strong symptom children, respectively, met diagnostic criteria for schizophreniform disorder (Table 2). The weak symptom group was significantly more likely to meet diagnostic criteria for adult schizophreniform disorder (OR, 5.1; 95% CI, 1.7-18.3) and the strong symptom group was at very high risk (OR, 16.4;, 95% CI, 3.9-67.8). The ORs remained virtually unchanged after controlling for sex, social class origins, and age-11 IQ scores. An analysis of attributable risk revealed that 42% of the age-26 schizophreniform cases in the cohort were associated with the presence of either weak or strong symptom presentation at age 11 years.

EVIDENCE FOR SPECIFICITY OF THE RELATION BETWEEN AGE-11 PSYCHOTIC SYMPTOMS AND AGE-26 PSYCHIATRIC DISORDER

Age-11 psychotic symptoms were related to age-26 schizophreniform disorder with notable specificity at the point of outcome. The strong symptom group members were significantly more likely than the other 2 groups to have an adult diagnosis of schizophreniform disorder, but were not more likely to have a diagnosis of mania or a depressive disorder (Table 2). However, both weak and strong symptom groups were more likely than no-symptom children to develop an anxiety

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disorder, albeit less markedly than for schizophreniform disorder.

Specificity at the point of prediction was also found as childhood psychotic symptoms provided incremental information beyond psychiatric diagnosis at age 11 years. None of the children in the cohort had been diagnosed as suffering from childhood schizophrenia. Of the 12 members of the strong symptom group available for follow-up at age 26 years, one half had no psychiatric diagnosis at age 11 years, suggesting that inclusion in the strong symptom group was not simply the result of high levels of general childhood psychopathologic processes. Furthermore, the 6 members of the strong symptom group with no childhood diagnoses were as likely to report delusions or hallucinations at age 26 years (n=3 [50%]) as the 6 strong symptom cases with childhood diagnoses (n=3 [50%]). These findings indicate that knowledge about a child's psychotic experiences per se has predictive validity for adult schizophreniform outcomes, rather than knowledge that the child has received a psychiatric diagnosis.

COMMENT

Using standardized psychiatric interview methods, we found a strong linear relationship between self-reported psychotic symptoms in childhood and adult schizophreniform disorder. Four limitations are apparent. First, the sample (at age 26 years) has not yet passed through the entire risk period for psychosis; approximately half of persons who later develop schizophrenia have been diagnosed by age 29 years.[42] However, we found that more than 70% of the strong symptom children had at least 1 criterion A symptom of schizophrenia at age 26 years. It is thus possible that more persons in this group may develop schizophreniform disorders in the future. Second, although a clinical assessment with a psychiatrist was not conducted at age 26 years, the structured diagnostic interviews were administered by health professionals and multisource data (self-, informant-, and observer-reported) were used to create a conservative and "narrow" definition of schizophreniform disorder. Third, this study is uninformative about outcomes of the rare childhood schizophrenia, schizoid, or schizotypal disorders,[43-45] which have been addressed in a few follow-up studies of highly selected clinical samples.[44,46,47] Finally, given the low base rates of the pathologic process studied, the findings from our cohort study are based on small groups and require replication.

Earlier, we suggested that the predictive validity of a compelling childhood risk factor for schizophreniform disorder should be judged by 3 criteria. The first criterion required that the risk factor bear a moderate-to-strong statistical relationship to adult schizophreniform outcomes. Our follow-forward analysis showed that strong symptom children were 16 times more likely to have a schizophreniform diagnosis by age 26 years (and individual psychosis symptoms) than were control children. Additionally, in terms of attributable risk, almost one half of the schizophreniform adults had reported at least some psychotic symptoms as children. Weak symptom children were also at increased risk for deleterious adult outcomes, lending support to the notion of a continuum of psychosis risk.[37]

The second criterion required that the risk factor should not falsely identify large numbers of children as at-risk who will never develop schizophrenic symptoms. Consistent with this, 25% of the age-11 strong symptom children met criteria for a diagnosis of schizophreniform disorder by age 26 years, and almost 70% had at least 1 of either hallucinations, delusions, disorganized speech, catatonia, or anhedonia. Furthermore, more than 90% of strong symptom children had occupational or social dysfunction as adults. Thus, if symptoms at age 11 years could be judged strong, true false-positives in which individuals predicted to be ill became healthy were few.

The third criterion stipulated that the risk factor should confer a specific risk for psychoses rather than pose a generalized risk for mental disorders. The strong symptom group was at increased risk for schizophreniform disorder but not for mania or depression at age 26 years. Indeed, the rate of mood disorders in the strong symptom group was below the prevalence of mood disorders in the cohort as a whole. In contrast, both the weak and strong age-11 symptom groups had elevated rates of anxiety at age 26 years. This might be expected given the fearful nature of paranoid and hallucinatory symptoms and is consistent with other cohort studies that have found social anxiety in childhood to be a risk factor for schizophrenia.[9]

It seems that prepubertal children who report seeing or hearing things that are not real or who report odd or delusional beliefs are at risk of developing psychotic illness in later life. None of the children had a diagnosis of childhood schizophrenia (ie, onset before age 12 years),[27] which is an extremely rare presentation accounting for fewer than 5% of all schizophrenic cases.[48] The children were not simply reporting features seen in childhood schizoid personality or schizotypal personality; although mild thought disorder can be a feature of these disorders, strange or odd perceptual disturbances are not.[45]

Do these findings suggest that a schizophrenia-type prodrome can be detected much earlier than previously thought? This seems unlikely if the schizophrenic prodromal period lasts an average of 2 years, from the onset of first noticeable changes through to the onset of frank psychotic symptoms.[36] However, because a prodrome begins with a pattern of noticeable, mostly behavioral, signs of deterioration, it is both possible and plausible that covert cognitive and/or perceptual changes precede more overt signs. Strange or unusual beliefs and experiences can be easily concealed, and are particularly likely to be so as children move from late childhood to early adolescence—a developmental stage marked by desire for peer approval. Thus, it is possible that the symptoms identified in this study at ages 11 and 26 years were part of an insidious process.

A better understanding of the normative cognitive experiences of prepubertal children may be useful for determining the nature and frequency of childhood symptoms with the greatest prognostic value. A practical implication of these findings for neuroscience is that it might be possible to screen for children with strong psychotic symptoms, and to enroll them for prospective study while they are young enough that a disease process has not yet had an impact on their lives and brains. If replicated, the present findings also have implications for clinical practice. When treating children with or without ad-

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justment problems, general practitioners or pediatricians could routinely ask about strange thoughts or experiences and, when reported, follow up with investigation into their nature, timing, and frequency. Where there is evidence of strange or unusual experiences and no plausible explanation exists, specialist psychiatric referral might be considered. From the public health perspective, our finding that children experiencing strong psychotic-type symptoms developed, as adults, schizophreniform disorder (25%), schizophrenic symptoms (70%), and/or social and occupational impairment (90%) attests that preventive intervention for such children is warranted.

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