Impact of the Great East Japan Earthquake on Child's IQ

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Objective To assess the neurodevelopmental effects of the Great East Japan Earthquake in resident children.

Study design The disaster on March 11, 2011, caused severe damage to the Sanriku coastal area, where we had been conducting a birth cohort study since 2003. It occurred in the middle of our 7-year-old examination. Approximately 500 mother-child pairs were compulsorily divided into 2 groups: 123 children finished the examination in the predisaster period, and 289 did in the postdisaster period. The remainder died or moved from that area. At the time of 7-year-old examination, we administered the Wechsler Intelligence Scale for Children-Third Edition and electrocardiography to assess autonomic function. According to the Child Behavior Checklist for ages 2-3 years and the Kaufman Assessment Battery for Children that had been administered at 30 months and 42 months of age, respectively, there were no significant differences in them between the 2 groups.

Results Verbal IQ, including information, arithmetic, and vocabulary subscores of the Wechsler Intelligence Scale for Children-Third Edition, at 7 years of age was significantly lower in the postdisaster group than in the predisaster group. However, there were no significant differences in performance IQ, full-scale IQ, or autonomic nervous indicators between the 2 groups.

Conclusions Since many schools were utilized as primary refuges after the disaster, the deficits in verbal IQ of 7-year-old children may have been due to the interrupted schooling. Further follow-up and more specific posttraumatic stress disorder testing will be required to determine the cause and long-term implications. *(J Pediatr 2015;167:745-51)*.

A massive earthquake with a magnitude of 9.0 Richter scale occurred off the northeastern Pacific coast of Japan on March 11, 2011. The so-called Great East Japan Earthquake generated a series of devastating tsunamis that destroyed many towns and villages near the coastal areas and also led to immense damage with 15 889 people dead and another 2597 people still missing, followed by an additional 3194 disaster-related deaths after that according to the official reports from the National Police Agency on November 10, 2014 and the Reconstruction Agency of Japan on December 26, 2014. Although such a disaster may induce behavior problems or posttraumatic stress disorder (PTSD) in children,[1-3] the effect on their neurodevelopment is not clearly understood because of the absence of either background data prior to the disaster or comparability between the affected and unaffected areas. In addition, studies examining the course and reversibility of psychophysiological alterations in children with PTSD are lacking.[4]

We had been performing a prospective birth cohort study, the Tohoku Study of Child Development (TSCD), prior to the earthquake, focusing both on the potential risks and benefits of fish eating during pregnancy to clarify the effects of neurotoxicants on child development in Japan.[5] The research field was comprised of 2 areas, an urban area and a coastal area, in the northeastern district of Japan. The latter area, the Sanriku coastal area of Miyagi prefecture, suffered destructive damage because of the great tsunamis at the time when we were conducting 7-year-old examinations of the cohort. Because of this disaster, the participants were compulsorily divided into predisaster and postdisaster groups. We hypothesized that because the external environment for children changed drastically, the disaster might have affected intellectual abilities and/or various nervous system functions of the children. The purpose of the current study was to assess the neurodevelopmental impact of the disaster, using successive data obtained from this cohort study, though some of the neurophysiological tests[6,7] at age 7 years could not be completed after the tsunamis destroyed our electromyography equipment for measuring brainstem auditory and visual evoked potentials (**Figure**).

CBCL	Child Behavior Checklist for ages 2-3	K-ABC	Kaufman Assessment Battery for Children
DHA	Docosahexaenoic acid	LF	Low frequency
ECG	Electrocardiography	PTSD	Posttraumatic stress disorder
EES	Evaluation of Environmental Stimulation	THg	Total mercury
HF	High frequency	TSCD	Tohoku Study of Child Development
ICCE	Index of Child Care Environment	WISC-III	Wechsler Intelligence Scale for Children-Third Edition

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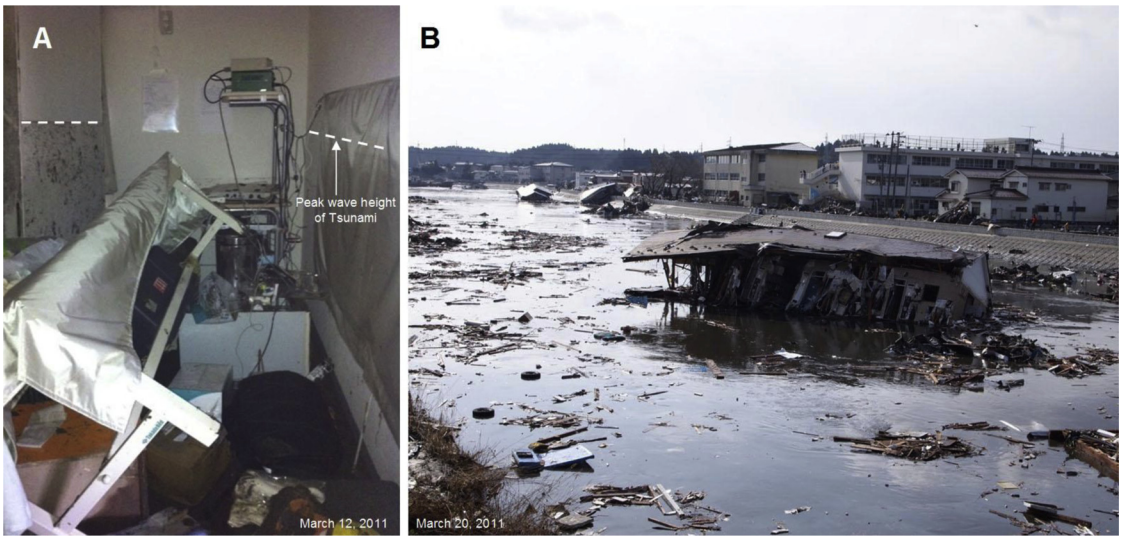

Figure. The ravages of the Great East Japan Earthquake. **A,** The tsunamis following the earthquake destroyed the electromyograph that we used for measurements of brainstem auditory and visual evoked potentials in our electrophysiological laboratory, and the device for assessing autonomic nervous function was barely saved. **B,** An elementary school (the 2 three-story buildings in the photo) located near our laboratory in the Sanriku coastal area was destroyed. For this reason, the pupils had no school to go for a month and transferred to another elementary school.

Methods

The study protocol of the TSCD has been described elsewhere.[5] The medical ethics committee of the Tohoku University Graduate School of Medicine approved this protocol. The nature of the procedure used in this study was explained fully to all parents, and the study was done with their written informed consent. At the starting stage of the TSCD in the coastal area, 749 mother-child pairs were registered in the years 2003-2006. To establish the study sample, the eligibility criteria included a singleton pregnancy, Japanese as the primary language, birth at term gestation (36-42 weeks) without obvious congenital anomalies or diseases, and a birth weight of more than 2400 g. Information about pregnancy, delivery, and the characteristics of the infants was obtained from medical records. Behavioral problems at the age of 30 months and intelligence and achievement at 42 months were assessed using the Child Behavior Checklist for ages 2-3 years (CBCL) and the Kaufman Assessment Battery for Children (K-ABC), respectively. After the examination of 160 children aged 7 years was finished, the disaster occurred. For this reason, the investigation was suspended on March 11, 2011. Three months after the disaster, a letter was sent to the mother-child pairs to confirm their safety and addresses. At that time, we learned that 2 mothers and 3 children had died, and the addresses of 10 mother-child pairs were unknown. In August 2011, the examination was resumed and data for 338 children could be obtained. Finally, 412 of the above 498 mother-child pairs participated in the present study. The data for 86 children (17.3%) were incomplete in either the CBCL or K-ABC, and they were excluded.

Measurements

In the same manner used in the urban area of the TSCD,[8,9] the Japanese version of the CBCL and the K-ABC were administered.[10,11] The CBCL is a parent-report questionnaire in which the child is rated for various behavioral problems, including externalizing and internalizing problems.[12] The K-ABC is comprised of simultaneous processing, sequential processing, mental processing, and achievement processing scales.[13] At the time of the examination at age 7 years, we administered the Japanese-version Wechsler Intelligence Scale for Children-Third Edition (WISC-III) on a holiday near the birthday of each subject,[14,15] with the exception of unusual cases after the disaster. The WISC-III is composed of several subtests for child's cognitive ability, and the raw scores obtained from the WISC-III are converted to scaled scores with adjustment for the chronological age according to the WISC-III manual.[14,15] These subtests with the scaled score are grouped into 2 scores: the verbal IQ and the performance IQ.

With the 7-year-old examinations, electrocardiography (ECG) also was conducted in a quiet laboratory, using an ECG-Amplifier 1271SP (NEC-Sanei Co, Tokyo, Japan) connected to a 2-channel analog-to-digital converter and a computer.[16] After the subjects rested in the supine position for 5 minutes, ECG amplitudes per millisecond were measured in the second lead for 30 seconds. The corrected QT interval was calculated from the averaged R-R and QT intervals, according to Bazett's formula[17]: corrected QT interval = (QT interval)/$\sqrt{}$(R-R interval). The QT interval was corrected for heart rate using the QT index (ie, [measured QT interval]/[predicted QT interval] × 100, where the predicted