The experience of large earthquakes in Japan and impact on body physique in schoolchildren

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Abstract Natural disasters have the potential to disrupt human life and society in a variety of ways. This is true of typhoons, floods, earthquakes, tsunamis, and a host of other events. On March 11, 2011, a large earthquake occurred off the Pacific coast of Tohoku, Japan. Called the 2011 Tohoku Earthquake, it was the most powerful earthquake recorded in Japanese history, and triggered powerful tsunami waves and an unprecedented nuclear accident. The tsunami caused serious damage to coastal areas in the Tohoku district. Since then, the area’s environment has undergone a huge change. Such environmental change may affect the growth and development of children living in and around damaged areas. Recently, data from investigation results have been revealed showing the relationship between the 2011 Tohoku Earthquake and child growth in Japan. These results are most likely related to changes in both the environment and the socioeconomic status of individuals living in the affected areas. Since the environment and areas in which children still live are in a transitional period from reconstruction efforts, the level of child growth and development will also have changed. Accordingly, future studies and investigations aim to determine if these secular trends are continuing, and intend to examine possible explanations and consequences.

Keywords: disaster, children, body physique

Introduction It is widely accepted that the growth rate of children, especially regarding gains or losses in height and weight, is a general marker of child health in a given community. In addition, knowledge of child height and weight is important from the standpoint of preventive medicine. In the case of children during the growth period, an evaluation of growth status regarding body physique is the basic measure for understanding a child’s health condition. Moreover, it is assumed that secular changes in childhood development are affected by environmental conditions, such as inadequate nutrition, poverty, and suffering. Such a change is assumed to reflect conditions in the nutritional, hygienic, and health status of children. An individual’s childhood years form a critical period for human growth and development. Accordingly, changes in environment and lifestyle create concerns for the growth of children.

Natural disasters can occur anywhere in the world. They occur in both developing and developed countries. While the extreme and negative effects of natural disasters have the potential to affect all humans, children are especially vulnerable. As a result, children may be disproportionately harmed by natural disasters, often with long-term effects. Early exposure to natural disasters can adversely affect a child’s physical, emotional, and psychological well-being, which can have both short and long-term impacts.

On March 11, 2011, a massive earthquake with a magnitude of 9.0 on the Richter scale occurred off the northeastern Pacific coast of Japan. Called the Great East Japan Earthquake, this disaster resulted in a series of devastating tsunamis that destroyed many towns and villages near coastal areas. The earthquake also resulted in the Fukushima Daiichi nuclear disaster, which caused the release of dangerous nuclear energy. This tragedy had an immediate impact on daily life in the region, and especially disrupted the normal eating and exercise habits of the inhabitants of Fukushima, Miyagi, and Iwate Prefectures.

Such a disaster may induce behavioral problems or post-traumatic stress disorder (PTSD) in children. Disasters of this type are known to affect the health of children by increasing the prevalence of psychiatric problems and physical symptoms. As for body physique, the discovery of underweight children subsequent to a disaster has been recognized as a serious health problem. The Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) reported increasing obesity trends.
among school children in Iwate, Miyagi, and Fukushima Prefectures after the Great East Japan Earthquake. In Japan, earthquakes are relatively frequent natural disasters, and may affect child growth. This short review discusses the relationship between natural disasters (especially large earthquakes) and body physique of schoolchildren in Japan.

The Great Hanshin-Awaji Earthquake of 1995 and child growth

In 1995, a devastating earthquake occurred in the Hanshin and Awaji areas of western Japan. This earthquake was referred to as The Great Hanshin-Awaji Earthquake, and caused great amounts of damage in those areas. The damage was extremely widespread and severe. Over 6,000 people lost their lives in the wake of the disaster. Although there are suggestions that this earthquake also affected child growth in those areas, only a few reports exist.

In 1999, Gowa et al. reported on the influence of the Great Hanshin-Awaji Earthquake on the physical growth of schoolchildren by using data from cross-sectional surveys. The physical data of these schoolchildren were divided into three groups, which were based on the grade of damage to their homes. The study results showed some features of child growth. First, the heights of schoolchildren belonging to the severely and moderately damaged groups showed no significant difference from those in the mildly damaged group. On the other hand, the bodyweights of schoolchildren in the severely and moderately damaged groups increased in both the year of the Earthquake and the year after. It has been suggested that there is a relationship between the bodyweight increase and a decrease in physical activity. Due to the destruction of houses and roads caused by the earthquake disasters, it is conceivable that the physical activity of children in those areas decreased. These results indicate that the aftermath of the Great Hanshin-Awaji Earthquake may have a long-lasting influence on the physical growth of children in the area. Although the earthquake itself was an instantaneous event, children have received severe ongoing mental stress as a result of the subsequent lifestyle changes. The authors also discussed the growth curve of junior high school students who were suspected of experiencing PTSD. The growth curve indicates differences from before and after the earthquake. Although the growth of height temporarily stagnated immediately after the earthquake, there was an eventual return to normal levels. In addition, another report suggested that the disaster induced both overeating and food refusal in children, which adversely affected the secretion of growth hormone. These examples indicate the possibility of an impact of the earthquake that is not observable by examining the group mean value on the growth of schoolchildren who experienced it.

The Great East Japan Earthquake of 2011 and child growth

The Great East Japan Earthquake of 2011 was a magnitude 9.0 earthquake. It was the fourth largest earthquake ever recorded worldwide, and the largest ever in Japan at the time. The earthquake caused a massive tsunami, which greatly damaged the Pacific coastal area of northeastern Japan. As a result, the lifestyle of the local populace was greatly altered. This was especially true for children. In local schools, yogo teachers have focused on assessing child growth (i.e., height, weight, and instances of child obesity or underweight children) among schoolchildren. This is because local children were mainly consuming a high-carbohydrate diet subsequent to the earthquake evacuation. In addition, it became difficult for children to play outdoors or in the schoolyard because of radiation exposure risks that resulted from the damaged nuclear power plant. This was especially prevalent in Fukushima Prefecture. In addition, many children were placed in temporary housing in coastal areas in Miyagi and Iwate Prefectures.

The Japanese Association for Human Auxology has established a technical committee for the investigation of the relationship between child growth and the Great East Japan Earthquake. The committee’s reports show the results of child growth changes in four coastal-area schools in the northern part of Miyagi Prefecture. The committee developed a growth curve for the area’s schoolchildren beginning at the time of entering elementary school. Based on changes in the heights and weights of these children, the committee examined whether the earthquake had impacted their developmental condition. As a result, children who experienced little weight gain during the year after the earthquake were especially observed. However, there were a few schoolchildren whose height increase was considered to have been affected. Although schoolchildren who lived in these areas had the tendency for obesity prior to the earthquake, there are many examples in which the condition of children with obesity deteriorated more rapidly due to significant weight gain that occurred after the earthquake. In these areas, there are children who lost relatives and acquaintances as a result of the disaster. The school environments of these children changed, which prevented them from freely using the schoolyard and/or gymnasium. Accordingly, it has been speculated that the stagnation of body weight gain and the deterioration of obesity in these schoolchildren were caused by complex factors, such as anorexia, overeating, sleep disorders, and low physical activity due to psychological stress caused by the earthquake. However, there is a current lack of sufficient evidence regarding these relationships.

In 2016, Yokomichi et al. also discussed the impacts of the earthquake on body physique, especially focusing on the prevalence of overweight and obese schoolchildren.
based on national survey data from the School Health Statistics Research Organization\textsuperscript{11}. This national survey could not be carried out in either Fukushima, Miyagi, or Iwate Prefectures because many schools were immediately affected by the March 11, 2011 earthquake. Therefore, the study compared data on the prevalence of overweight schoolchildren from a 2012 examination with data on the same prevalence from a 2010 examination that involved all three prefectures. This comparison was performed to determine whether or not the prevalence of overweight or obese schoolchildren had increased after the earthquake. These results showed that there were no consistent trends in the prevalence of overweight individuals among junior high school and high school students aged 12-17 years in the three affected prefectures. However, in elementary school children, various trends among each age and gender group were observed in the Fukushima and Miyagi prefectures. The study also indicated that no noteworthy change in the prevalence of overweight school children was observed among primary school girls (6-12 years of age) in Iwate Prefecture. As these data were the results of a short-term observation, further long-term observation is considered to be necessary to ascertain the extent to which the disaster has affected the growth of children in these prefectures.

The Great East Japan Earthquake of 2011 and child growth in Sendai, Japan

Sendai is a city in Miyagi Prefecture. It has received a variety of impacts from the Great East Japan Earthquake. Tohoku University and the Sendai City Education Commission have also been monitoring the secular changes in the growth of 6th year children in primary schools (11-12 years of age) and 3rd year children in junior high schools (14-15 years of age) in the city of Sendai from the pre-World War II era until the present time\textsuperscript{(2,13)}. The mean height of all Sendai City schoolchildren saw little change, and a slight decrease in the mean bodyweight of those schoolchildren was observed before the 2011 earthquake\textsuperscript{(13)}. In the time period after the disaster, the mean height of 6th year children in primary schools barely changed from the time period before (Table 1)\textsuperscript{(14)}. In contrast, there was a slight increase in the mean bodyweight of boys, but almost no such change was observed in girls.

Future consideration of natural disasters and impacts on child growth

This short review focused on the relationship between large earthquakes and child growth in Japan. Special attention was given to body physique. However, research has indicated that a variety of natural disasters, including

| Year | n  | Height (cm) | Weight (kg) | n  | Height (cm) | Weight (kg) |
|------|----|-------------|-------------|----|-------------|-------------|
|      |    | mean        | S.D.        |    | mean        | S.D.        |
| 2007 | 4594 | 145.8       | 7.36        | 4397 | 147.3       | 6.60        |
| 2008 | 4608 | 145.8       | 7.05        | 4501 | 147.6       | 6.63        |
| 2009 | 4584 | 145.6       | 7.16        | 4352 | 147.3       | 6.76        |
| 2010 | 4873 | 145.5       | 7.10        | 4467 | 147.2       | 6.70        |
| 2011 | 4783 | 145.4       | 7.18        | 4394 | 147.3       | 6.71        |
| 2012 | 4791 | 145.6       | 7.11        | 4475 | 147.2       | 6.60        |
| 2013 | 4767 | 145.4       | 7.01        | 4360 | 147.2       | 6.50        |
| 2014 | 4630 | 145.9       | 7.18        | 4344 | 147.1       | 6.68        |
| 2015 | 4645 | 145.9       | 7.13        | 4362 | 147.2       | 6.69        |
| 2016 | 4335 | 146.0       | 7.17        | 4133 | 147.3       | 6.72        |

Shown are the number of participants (n), mean height, weight and standard deviation (S.D.) by gender in 6th graders of primary school in Sendai city. (Reproduced from Kurokawa et al. 2017 Tohoku gakkou hoken gakkai kaishi\textsuperscript{(14)})
heat waves, droughts, and floods, affect the growth and development of children all over the world\textsuperscript{7,4,15,16}. It is known that the stage of growth and development during childhood is important because of the major influence it has on a future healthy life and development. Therefore, it is important to pay special attention to children’s growth and development during and after the occurrence of a natural disaster.

**Conflict of Interests**

The author declares that there is no conflict of interests regarding the publication of this article.

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