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Families' Health after the Great East Japan Earthquake: Findings from the Tohoku Medical Megabank Project Birth and Three-Generation Cohort Study

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Infectious diseases, chronic diseases, and mental disorders in both adults and children are reported after disasters occur. The correlation between chronic diseases and mental disorders has also been reported. Moreover, disasters may affect perinatal outcomes. Thus, both adult and child health should be carefully monitored in disaster aftermath. A prospective cohort study of pregnant women and their families, the Tohoku Medical Megabank Project (TMM) Birth and Three-Generation Cohort Study (TMM BirThree Cohort Study), has been conducted since 2013. A total of 73,529 family members participated in the TMM BirThree Cohort Study. Among siblings, the proportion of "small for gestational age" was the same in the pre- and post-disaster periods. Among parents and grandparents who answered the baseline questionnaire, 5.6% in the inland area and 19.8% in the coastal area had their houses totally/mostly destroyed by the Great East Japan Earthquake. Although a depression trend due to house damage was not observed in mothers, the proportion of psychological distress was high according to house damage (P for trend = 0.04). Among parents, there was an increase in overweight persons (P for trend = 0.004 in mothers and < 0.0001 in fathers) and in the number of smokers based on the severity of house damage (P for trend = 0.002 in mothers and < 0.0001 in fathers), whereas no such trend was observed in grandparents. Continuous monitoring and support for those who need are essential. Moreover, utilizing existing cohort studies to investigate health status when we face a new disaster is desirable.

Keywords: adults; children; Great East Japan Earthquake; health status after the disaster; prospective cohort study
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Introduction

Between 2000 to 2019, 368 natural disaster events occurred worldwide (CRED and UNDRR 2021). Floods and storms are the most frequent types of natural disasters, accounting for 72% of the events in the last two decades. However, the average number of deaths from earthquakes was higher than that of other disaster types (CRED and UNDRR 2021). Japan often experiences large earthquakes, which have resulted in tragic losses among many people. In particular, 15,899 people were lost after the Great East Japan Earthquake, and 2,526 people were still missing (National Police Agency 2021).

Many physical and mental health consequences of disasters have been reported. After Typhoon Morakot and the flood in Taiwan in 2009, a higher rate of *E. histolytica* seroconversion was observed in evacuees than in community people (Lin et al. 2015). Morbidities of cardiovascular disease, respiratory disease, and injury in elderly people both 4 and 12 months after Superstorm Sandy in 2012 were higher in affected areas than in non-affected areas in New York (Lawrence et al. 2019). A higher prevalence of hypertension was observed in the 19-day period of the 2008 Sichuan earthquake, including in the younger generation: 39.7% of males and 25.0% of females had hypertension in the post-disaster period compared to 17.4% of men and 10.7% of women who had hypertension in the pre-disaster period (Hung et al. 2013). In relation to the Great East Japan Earthquake, according to the Fukushima Health Management Survey, there are several reports on the positive association of disaster or evacuation due to a disaster with hyperuricemia (Honda et al. 2021), hypertension in males (Ohira et al. 2016), liver dysfunction (Takahashi et al. 2017), and chronic kidney disease (Hayashi et al. 2017). People with some diseases are at risk of discontinuing their treatment due to disasters. About half of the evacuees during Hurricane Katrina with chronic diseases reached shelters without their medicines (Greenough et al. 2008). According to a review by Galea et al. (2005), the prevalence of posttraumatic stress disorder (PTSD) after natural disasters varied from 5% to 60%, which was lower than that after human-made or technological disasters. This may have been because natural disasters affect larger areas and study participants are usually included in a wider area than human-made or technological disasters. In another review, Matsumoto et al. (2016) mentioned that the prevalence of probable PTSD among municipal and hospital medical workers was higher than that in general Japanese after the earthquake.

Such mental health problems may correlate with health conditions or health risk behavior. After the 1988 Armenian earthquake, the incidence of hypertension, heart disease, arthritis, and diabetes increased within the first six months, and people who experienced loss had higher morbidity due to these illnesses (Armenian et al. 1998). In Thailand, long-lasting flood is associated with serious mental illness, and the prevalence of hypertension and diabetes is also associated with serious mental illness (Yoda et al. 2017). PTSD in women is reported to be associated with metabolic syndrome, but it is still challenging to conclude that there is a sex difference in the association between PTSD and metabolic syndrome (LIhua et al. 2020). However, a more recent study targeting evacuees of the Fukushima Daiichi Nuclear Power Plant found that PTSD was strongly associated with metabolic syndrome only in women (Takahashi et al. 2020). The long-term impact of a disaster on age- and sex-stratified populations has also been reported. An individual experience was not associated with all-cause mortality in both men and women aged 35 to 49, 10 years after the 2004 Indian Ocean tsunami, whereas posttraumatic stress reactivity was associated with higher mortality in males aged over 50 years, and living in tents, barracks, or camps after the tsunami was associated with higher mortality in females aged over 50 (Frankenberg et al. 2020). Thus, the impact of disasters may differ by generation and sex.

Children are particularly vulnerable to disasters. Project Ice Storm investigated the long-term effects of the 1998 Quebec Ice Storm on children who were exposed to it, particularly as fetuses. They found that the timing of exposure explained 1.7% of the variance in birth weight, and objective maternal stress explained 9.4% of the variance in head circumference to birth length ratios (Dancause et al. 2011). Furthermore, Project Ice Storm reported that there was a potential risk of obesity in children aged 5.5 years old, who were exposed to maternal stress in-utero (Dancause et al. 2012). They also reported that DNA methylation mediated the association between maternal stress during the storm and child body mass index (BMI) and waist-to-height ratio of children at 13 years of age (Cao-Lei et al. 2015). Another study reported that children who immigrated from areas near the Chernobyl explosion to Israel had a higher prevalence of asthma (Kordysh et al. 1995). After the Great East Japan Earthquake, we conducted several surveys on children in both physical development and health condition (Kikuya et al. 2015; Matsubara et al. 2016, 2017). A nationwide nursery school survey found that there were more overweight children in the three most affected prefectures a year after the earthquake than in other prefectures (Kikuya et al. 2017). Experiences of tsunamis and evacuation to shelters were associated with atopic dermatitis in males in nursery schools, and destruction of, or relocation from, houses were associated with asthma in females (Ishikuro et al. 2017). This finding was also observed in elementary and junior high school students in Miyagi Prefecture. The experience of a tsunami and some difficulties in daily life were associated with severe eczema (Miyashita et al. 2015). Kuniyoshi et al. (2018) also reported a strong association between eczema and some difficulties in daily life in children. Thus, both adult and child health should be carefully monitored in disaster aftermath.

Tohoku University, located in Miyagi Prefecture,

where the highest number of lives were lost after the Great East Japan Earthquake, established the Tohoku Medical Megabank Project (TMM) with Iwate Medical University in the next prefecture after the Great East Japan Earthquake (Kuriyama et al. 2016). The project has conducted two cohort studies: the Community-Based Cohort Study, and the Birth and Three-Generation Cohort Study (TMM BirThree Cohort Study). The former study targeted adults living in Miyagi and Iwate Prefectures, and the latter study targeted families mostly living in Miyagi Prefecture. As the TMM BirThree Cohort Study recruited several generations from grandparents to grandchildren, we would like to introduce the TMM BirThree Cohort Study, and investigate health status through generations.

Design and Data Collection of the TMM BirThree Cohort Study

We previously introduced the design of the TMM BirThree Cohort Study (Ishikuro et al. 2018; Kuriyama et al. 2020). The protocol of the TMM BirThree Cohort Study was approved by the Tohoku Medical Megabank Organization internal review board (No. 2013-1-103-1). We asked pregnant women and women within a month of delivery, who lived in Miyagi Prefecture and some parts of Iwate Prefecture to participate in the TMM BirThree Cohort Study. Pregnant women were contacted at obstetric hospitals or clinics. Some pregnant women visited our research center and provided informed consent. Family members and relatives of participating pregnant women were also asked to participate in the TMM BirThree Cohort Study, regardless of their residence. Finally, 73,529 family members (23,143 newborns, 9,459 siblings, 22,493 mothers, 8,823 fathers, 2,451 grandfathers, 5,607 grandmothers, 78 great-grandparents, and 1,475 extended families) participated in the TMM BirThree Cohort Study (Kuriyama et al. 2020).

For child participants, both newborns and their siblings, questionnaires were mailed to parents when the children were 6, 12, 24, 36, 42, 48, and 60 months old. Additionally, participants as siblings answered a questionnaire when they were recruited. We asked the children's guardians to bring them to research centers for health assessments when they were 4, 10, and 16 years old. We collected data on health examinations for infants from municipalities and school health records. Medical records during the pre- and postnatal periods were also collected. Moreover, data on maternal and child health handbooks were collected from both adult and child participants. Adult participants answered a questionnaire consisting of disaster experience, health condition, health-related lifestyle and social status at baseline. Only women who were recruited during pregnancy to the postpartum period answered the questionnaire a year after delivery, since we avoided any harmful contents for maternal condition. Hereafter, we will call this the "baseline questionnaire". Participants underwent blood and urine tests and physiological examinations at research centers, obstetric hospitals, or clinics. During the follow-up period, we asked participants to complete a questionnaire once every six months or one year, and took blood and urine tests and physical examinations at research centers once every four or five years.

We report whether the prevalence of small for gestational age (SGA) among children who participate as siblings of newborns is different between the pre- and post-disaster periods. We also report the disaster experience of parents and grandparents participating in the TMM BirThree Cohort Study and their health-related demographics and health conditions at baseline.

Health-Related Status in Children

To analyze the effect of the Great East Japan Earthquake on fetal growth, we used data of pregnant women who answered the baseline questionnaire for both mothers and siblings. We extracted women who gave birth between March 11, 2009, to March 10, 2014, and divided them into four groups: 2009-2010 as "non-exposed," 2011 as "exposed," and 2012 and 2013 as "post-exposed." Multiple pregnancies were excluded from the study. SGA infants were defined as infants whose birth weight was in the < 10th percentile. Chi-squared test and analysis of variance (ANOVA) were used for comparisons among the groups, as appropriate. The data contained a total of 1,205, 925, 1,218, and 1,307 deliveries in 2009-2010, 2011-2012, 2012-2013, 2013-2014, respectively (Table 1). The proportion of SGA infants was not significantly different among the four groups.

Impacts on reduced gestational age and lower birth weight have been reported after Hurricane Katrina (Hamilton et al. 2009), earthquakes in China (Tan et al. 2009), and floods (Tong et al. 2011), however, other studies indicated that there were no associations between a disaster and preterm birth or low birth weight, which is consistent with our results (Sherrieb and Norris 2013; Grabich et al. 2017; Ishii et al. 2017). Further studies are needed to measure the impact on offspring. In particular, as we did not collect mothers' and siblings' residences when the siblings were born, it is necessary to investigate whether there is a difference in the proportion of SGA between coastal and inland areas.

Health-Related Status in Parents and Grandparents

Withdrawals were excluded from the analysis, and those who participated two or more times, as they had other children, were considered only in the first enrollment for the TMM BirThree Cohort Study. In total, 38,667 people remained (21,987 mothers, 8,685 fathers, 2,439 grandfathers, and 5,556 grandmothers). A total of 27,119 people answered the baseline questionnaire and their self-reported addresses appeared in the residence certificate at recruitment. Although we did not collect addresses at the time of the Great East Japan Earthquake, we divided residence into inland and coastal areas according to the address appearing

Table 1. Characteristics of mothers and infants whose gestation period includes March 11 by each year.

	March 11, 2009-March 10, 2011 n = 1,205		March 11, 2011-March 10, 2012 n = 925		March 11, 2012-March 10, 2013 n = 1,218		March 11, 2013-March 10, 2014 n = 1,307		
	mean/n	SD/%	mean/n	SD/%	mean/n	SD/%	mean/n	SD/%	P-value
Maternal age (years)*	28.1	4.0	29.1	4.3	29.5	4.2	29.3	4.3	< 0.0001
Educational attainment ≥ University	172	21.1	156	24.8	214	24.6	237	25.7	0.1
History of obstetric disease									
Hypertensive disorders of pregnancy	36	3.0	29	3.1	33	2.7	39	3.0	0.95
Gestational diabetes mellitus	6	0.5	7	0.8	8	0.7	14	1.1	0.4
Placental abruption	3	0.3	4	0.4	4	0.3	4	0.3	0.9
Placenta previa	9	0.8	10	1.1	10	0.8	12	0.9	0.9
Threatened premature delivery	130	10.8	98	10.6	126	10.3	131	10.0	0.9
Other abnormal pregnancy	72	6.0	70	7.6	73	6.0	69	5.3	0.2
Sex									
Male	619	51.4	451	48.8	629	51.6	677	51.8	0.5
Female	586	48.6	474	51.2	589	48.4	630	48.2	
Gestational age (weeks)*	39.2	1.5	39.0	1.6	39.0	1.6	39.0	1.6	0.005
Birth weight (g)*	3,063.70	406.5	3,030.70	401.2	3,044.20	412.8	3,054.20	401.1	0.3
Parity									
Primipara	838	69.5	628	67.9	831	68.2	936	71.6	0.2
Multipara	367	30.5	297	32.1	387	31.8	371	28.4	
Small for Gestational Age	65	5.4	46	5.0	63	5.2	53	4.1	0.4

Data are shown as number (n) and %.
*These variables are shown with mean and standard deviation (SD).

on the residence certificate at recruitment. The percentage of people whose houses were totally/mostly destroyed by the Great East Japan Earthquake were 5.6% in the inland area and 19.8% in the coastal area, half/partly destroyed were 43.9% in the inland area and 39.6% in the coastal area, and not destroyed or people who did not live in the disaster-hit area were 50.5% in the inland area and 40.6% in the coastal area (Table 2). People who felt that their lives were affected when they remembered the disaster were 0.93% in the inland area and 0.97% in the coastal area. In the coastal area, 29.2% had life-threatening experiences resulting from the earthquake or tsunami, whereas 21.5% in the inland area had such an experience. The proportion of people who lost somebody close to them was higher in the coastal area (33.1%) than that in the inland area (18.9%).

We divided people by their familial role (mother, father, grandfather, and grandmother), and investigated the association between the severity of disaster experience, defined by the amount of house destruction and their health-related demographics. Age among groups divided by disaster experience was compared using ANOVA and a linear model. Overweight, defined by BMI $\geq$ 25 kg/m^2, current smoker, educational attainment (university or graduate school), Athens Insomnia Scale (AIS) $\geq$ 6, sleeping pill user, Kessler 6 scale (K6) $\geq$ 13, and Center for Epidemiologic Studies Depression Scale (CESD) $\geq$ 20 (Vilagut et al. 2016) were compared among the groups using chi-squared test and Cochran-Armitage test. Fathers, grandfathers, and grandmothers in the group of consisting of people whose houses were totally/mostly destroyed had a higher proportion of CESD $\geq$ 20 than those whose houses were not destroyed or who did not live within the disaster-hit area (Table 3). This result can be explained by the different intervals from the Great East Japan Earthquake to the date of filling out the baseline questionnaire between mothers and other family members. However, mothers and grandmothers tended to have a higher proportion of K6 $\geq$ 13, according to the severity of house damage. Moreover, referring to Table 2, people who lived in the coastal area at recruitment experienced more severe house destruction than people in the inland area. It indicates that the coastal area might have had more damage from the Great East Japan Earthquake, though some of them might have moved inland from the coastal area after the disaster.

Table 2. Parents and grandparents characteristics.

(n = 27,119)

		Inland area		Coastal area	
		n	%	n	%
Family members					
	Mother	7,920	48.9	5,636	51.7
	Father	4,630	28.6	2,853	26.2
	Paternal grandfather	374	2.3	255	2.3
	Maternal grandfather	794	4.9	484	4.4
	Paternal grandmother	582	3.6	407	3.7
	Maternal grandmother	1,911	11.8	1,273	11.7
Sex					
	Male	5,798	35.8	3,592	32.9
	Female	10,413	64.2	7,316	67.1
House destruction					
	None	8,022	50.5	4,380	40.6
	Half/partly destroyed	6,971	43.9	4,269	39.6
	Totally/mostly destroyed	882	5.6	2,141	19.8
Memories of the earthquake					
	I don't want to remember it, but I remember it or dream about it.	782	5.0	741	7.0
	I feel severely disturbed when I recall it.	932	5.9	760	7.1
	Recalling it causes physical responses (feelings of strain in the heart, breathing difficulty, sweating, dizziness, etc.).	445	2.8	353	3.3
	I try not to think about it, talk about it, or feel anything about it. Or I try to avoid activities, people, or places that remind me of it.	1,130	7.2	947	8.9
	Distress caused by recalling it interferes with or affects my daily life.	146	0.93	103	0.97
Experiences of the disaster and losses					
	I experienced the feeling that my life is at risk due to an earthquake or tsunami.	3,395	21.5	3,121	29.2
	I witnessed another person's death or a scene where another person's life was in danger due to an earthquake or tsunami.	1,494	9.5	1,998	18.7
	(If answering "yes" to either of the above two questions) I felt intense fear, helplessness, or dread at that time.	2,685	57.6	2,585	62.9
	Somebody close to me died or went missing due to the impact of the earthquake.	2,912	18.9	3,476	33.1

Table 3. Comparison of health status and cardiometabolic events by house destruction by the Great East Japan Earthquake for each family member.

Mother	House destruction: None n = 7,000		Half/partly destroyed n = 5,006		Totally/mostly destroyed n = 1,461			
	mean/n	SD/%	mean/n	SD/%	mean/n	SD/%	P	P for trend
Age*	33.0	4.9	33.5	4.8	32.9	5.0	< 0.0001	0.053
BMI ≥ 25kg/m^2	824	12.1	665	13.8	204	14.5	0.007	0.002
Current smoker	326	4.7	246	5.0	98	6.9	0.004	0.004
Current drinker	1,578	22.7	1,213	24.4	312	21.5	0.03	0.8
Educational attainment ≥ University	2,212	31.9	1,292	26.0	297	20.5	< 0.0001	< 0.0001
AIS ≥ 6	1,860	26.9	1,410	28.6	401	27.8	0.1	0.1
Sleeping pill user	68	0.98	44	0.9	20	1.4	0.2	0.4
K6 ≥ 13	358	5.2	293	5.9	89	6.2	0.04	0.04
CESD ≥ 20	698	10.6	557	11.9	161	11.7	0.09	0.06
Hypertension	267	4.0	235	5.0	78	5.7	0.006	0.001
Diabetes mellitus	182	2.8	123	2.6	39	2.9	0.96	0.96
Hyperlipidemia	159	2.4	110	2.3	32	2.4	0.96	0.8
Father	House destruction: None n = 3,725		Half/partly destroyed n = 2,875		Totally/mostly destroyed n = 764			
	mean/n	SD/%	mean/n	SD/%	mean/n	SD/%	P	P for trend
Age*	33.3	5.8	34.0	6.0	33.3	6.0	< 0.0001	0.01
BMI ≥ 25kg/m^2	1,006	27.3	868	30.5	253	33.5	0.0004	< 0.0001
Current smoker	1,226	33.8	1076	38.6	325	43.9	< 0.0001	< 0.0001
Current drinker	2,737	73.6	2145	74.8	542	71.1	0.1	0.6
Educational attainment ≥ University	1644	44.3	1049	36.7	203	26.7	< 0.0001	< 0.0001
AIS ≥ 6	685	18.6	646	22.7	148	19.6	0.0002	0.01
Sleeping pill user	61	1.7	63	2.2	20	2.6	0.1	0.03
K6 ≥ 13	285	7.7	259	9.1	57	7.5	0.1	0.4
CESD ≥ 20	353	9.7	338	12.1	91	12.4	0.004	0.002
Hypertension	369	10.2	330	11.9	85	11.7	0.08	0.052
Diabetes mellitus	138	3.8	139	5.0	32	4.4	0.06	0.09
Hyperlipidemia	383	10.6	295	10.6	84	11.5	0.7	0.6
Grandfather	House destruction: None n = 643		Half/partly destroyed n = 1147		Totally/mostly destroyed n = 242			
	mean/n	SD/%	mean/n	SD/%	mean/n	SD/%	P	P for trend
Age*	63.5	6.1	63.1	6.0	62.9	6.4	0.3	0.1
BMI ≥ 25kg/m^2	215	33.7	392	34.3	86	36.1	0.8	0.5
Current smoker	136	22.5	250	23.0	70	30.2	0.047	0.06
Current drinker	511	79.7	927	80.9	184	76.0	0.2	0.5
Educational attainment ≥ University	183	28.7	337	29.7	49	20.5	0.02	0.09
AIS ≥ 6	64	10.2	168	15.0	36	15.5	0.01	0.009
Sleeping pill user	31	4.9	76	6.7	17	7.1	0.3	0.1
K6 ≥ 13	10	1.6	22	1.9	7	3.0	0.4	0.2
CESD ≥ 20	23	3.9	70	6.5	17	7.7	0.04	0.01
Hypertension	312	53.2	572	53.9	120	54.6	0.9	0.7
Diabetes mellitus	153	28.1	273	27.8	48	23.2	0.4	0.3
Hyperlipidemia	208	38.0	395	39.9	73	36.3	0.6	0.97
Grandmother	House destruction: None n = 1,461		Half/partly destroyed n = 2,322		Totally/mostly destroyed n = 574			
	mean/n	SD/%	mean/n	SD/%	mean/n	SD/%	P	P for trend
Age*	59.3	6.3	59.4	5.9	59.3	6.2	0.8	1.0
BMI ≥ 25kg/m^2	368	25.6	540	23.7	141	25.3	0.4	0.5
Current smoker	141	10.1	196	8.8	65	12.0	0.05	0.6
Current drinker	654	45.3	1056	45.7	245	43.1	0.54	0.5
Educational attainment ≥ University	115	8.0	144	6.3	31	5.5	0.06	0.02
AIS ≥ 6	321	22.6	538	23.9	140	25.6	0.4	0.2
Sleeping pill user	129	8.9	209	9.1	67	11.8	0.1	0.1
K6 ≥ 13	53	3.7	125	5.5	31	5.5	0.04	0.03
CESD ≥ 20	126	9.5	256	12.3	73	14.3	0.006	0.001
Hypertension	451	34.1	730	35.0	189	37.4	0.4	0.2
Diabetes mellitus	168	13.5	314	15.9	59	13.1	0.1	0.6
Hyperlipidemia	387	30.0	669	32.9	142	30.0	0.2	0.5

Data are shown as number (n) and %. *These variables are shown with mean and standard deviation (SD).
BMI, body mass index; AIS, the Athens Insomnia Scale; K6, Kessler 6; CESD, the Center for Epidemiologic Studies Depression Scale.
P-values for trend (P for trend) were analyzed by a linear model for continuous variables and Cochran-Armitage test for categorical variables.

The tendency of increased prevalence for BMI ≥ 25 kg/m^2 and current smoking by the severity of house damage was observed in mothers and fathers, whereas no such trend was observed in grandparents.

Risk for Cardiovascular Events in Parents and Grandparents

In the baseline questionnaire, we asked about medical history of hypertension, diabetes, and hyperlipidemia. Although these were cross-sectional analyses, mothers who experienced severe house destruction tended to have a higher prevalence of hypertension (Table 3). In a previous study, we reported that house destruction was directly and indirectly associated with the prevalence of hypertensive disorders of pregnancy (Ishikuro et al. 2021b). Long-term monitoring of blood pressure levels is also essential. Conversely, there was no association between house destruction and diabetes or hyperlipidemia in each family member.

Healthcare Support for Participants and Community

The TMM BirThree Cohort Study has returned the participants' questionnaire results, blood and urine tests, and physiological examinations. When the participants received their results, they could review their results and were provided recommendations to see a doctor in the sheet where necessary. When the results were abnormal, the participants were notified separately, apart from receiving the sheet. In particular, when we found severe psychological distress or severe depression in the study, clinical psychologists supported the improvement of participants' mental health by a phone call or by face-to-face discussion if participants requested it. The Tohoku Medical Megabank Organization (ToMMo), which carries out the TMM at Tohoku University, also had a call center to support participants' general health, mainly during the baseline period, the years 2013 to 2017. We reviewed reports of call centers from October 2013 to September 2017. There were 8,167 cases where people called the call center, and 1,249 cases among them were consultations about children. Most cases were related to the symptoms and treatments of diseases.

Since 2020, we have created an application that enables our participants to look at the results of the questionnaires and health examinations that they have undergone in the past. We will officially and widely disseminate the application to participants from October 2021. This will enable them to show their physicians the results, which will be helpful for healthcare.

We also cooperated with municipalities to support the community. For example, we created a leaflet based on our results from the perspective of transgenerational health risk, which is now disseminated to multiple generations widely. The content of the leaflet was related to the risk of smoking during pregnancy, which can affect the mother's own hypertensive disorders of pregnancy (Umesawa and Kobashi 2017) and low birth weight (Ward et al. 2007). In our previous reports, low birth weight was also associated with hypertensive disorders of pregnancy during pregnancy (Wagata et al. 2020), and some type of hypertensive disorders of pregnancy might be associated with possible autistic behavior of offspring at two years old (Ishikuro et al. 2021a); therefore, maternal risk behavior can affect children and grandchildren's health through generations, especially when the first generation of children are born with low birth weight.

Conclusion

Disaster experience may have a complex effect on children and adults. Continuous monitoring and support for those who need are essential. Although the TMM BirThree Cohort Study observed no effect on child status at birth, we still need to monitor their health and continue to support it. Because health status in the parents' generation may affect the health status in the next generation. Furthermore, we often face disasters such as the recent COVID-19 pandemic. Several cohort studies in the Netherlands and the UK, which have already collected information over multiple generations, are now investigating the spread of COVID-19 and its impact on the risk of non-communicable diseases (Kwong et al. 2020; Mc Intyre et al. 2021). In a study on data from the UK Biobank, high social deprivation was associated with the risk of death from COVID-19 (Woodward et al. 2021). Prospective cohort studies might be useful for monitoring pre- and post-disaster changes in people's lives; therefore, it is desirable to utilize existing cohort studies to investigate health status when we face a new disaster.

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Conflict of Interest

The authors declare no conflict of interest.

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