

Lessons for Disaster Management and Recovery

Shinjiro Nozaki Senior consultant, WHO Centre for Health Development



Thank you very much for the kind introduction, Professor Shibuya. I was wondering whether I should speak in English or in Japanese. But the original idea was Dr. Alex Ross who was to deliver the keynote lecture in English and I was to augment as supplementary information in Japanese. However, yesterday, due to the family problem, he was not available yesterday and there was no keynote lecture. However, he insisted that this material to be delivered to the

audience. So first, I would like to use his materials and then I would like to use my slides to augment what he had to say.

This is the WHO Center for Health Development where I belong to. That is WHO Kobe Center. That is the nickname. It has a deep relationship with disasters. There was Hanshin Great Earthquake and it was established as a symbol of the reconstruction from the earthquake together with Kobe and WHO center was established. So, immediately after the foundation, it had devised various schemes against disasters. So, these are some of the things that I would like to mention today.

First of all, this is WHO and what we consider the most important is global health security because this has everybody's business because it leads to health and security for all the people in the world. This is global health security. At the center is health security. When it comes to health, it has a political relevance as well as economic relevance. And also, it is connected to food security and environmental security. So it is very closely linked to all these aspects of security.



Why we need security? Because, that is required for our people living in happiness and in a healthy state; I believe that that is the common value sense of human beings.

This is a map. This is an airplane that is crisscrossing the world on a real-time basis. This is the number of airplanes flying all over the world. In the process of globalization, people are coming and going and moving around. That is the globalization in which we have to consider health security.



So the risk related the health? The most immediately one is the Kumamoto earthquake. These are the earthquakes and natural disasters. What do we do? This is a safe hospital framework. I do not know your image about WHO but we go to the forefront together with DMAT or firefighters or self-defense forces and police. We rescue and help people. But rather than going to the forefront, WHO works at the background; that is, to make the regulation studies to do the monitoring and supervision and that's what we do at the background.

For instance, in Kumamoto earthquake what did we do? There were reports about the Kumamoto earthquake and MHLW Kumamoto prefecture, Kumamoto city makes the announcements. However, all of this information were in Japanese and also we have the WHO and CNN information in English. We saw these English reports and these data all two times or three times difference. Also, it was true with Great East Japan Earthquake.

Also in the Kumamoto earthquake, because this WHO is at Kobe Center and it is not Japan center but it is coincidentally located in Kobe. So this center was and is responsible for research. But because it is in Japan, there were lots of people who can translate Japanese into English. So this all data can be updated. That was why we translated the Japanese data into English and sent these data to WHO headquarters. If the headquarters deemed this data necessary to be transmitted, then they were free to do that. So, we devised the data and we monitored the data. That saved hospital framework and it is to the regulation with which hospitals become safe even in emergencies.

It was GEJE or Great East Japan Earthquake. In WHO it was deemed as a very complicated disaster because it was a triple one comprised of earthquake, tsunami, nuclear accident. One after the other various things that have happened and we were overwhelmed by that. People said because it is Japan, Japanese people can overcome them. Most deaths were caused by

Great East Japan Earthquake

- Triple disaster:
 - earthquake, tsunami, nuclear accident
- Most deaths: tsunami
- Long term impact
 - Temp. housing and psycho-social impact
 - Fear and uncertainty
 - NCD management, elder-care, continuity
 - Insufficient health workers

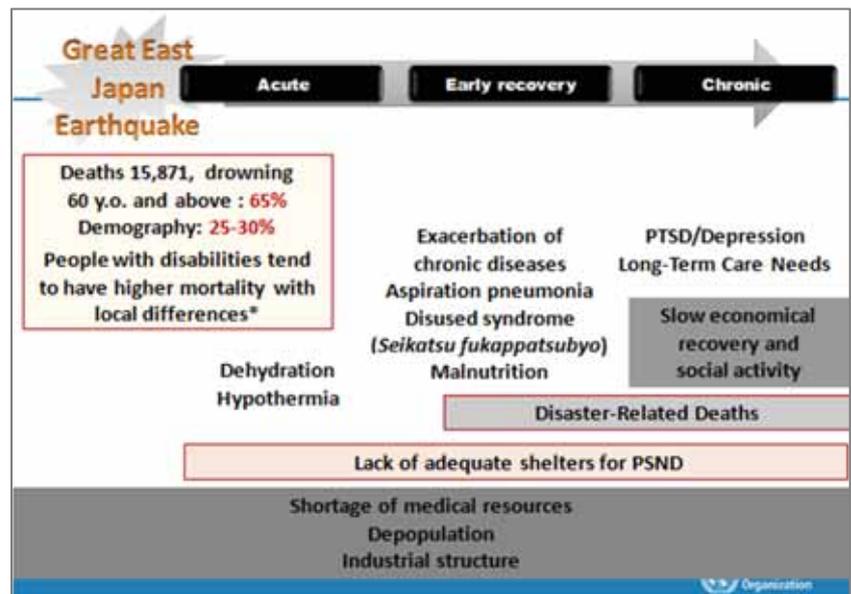


SOURCE: World Bank Knowledge NIKEL, 2012



tsunami and others are disaster-related deaths that happen as secondary death. So direct, this is only part of the total casualties.

Also it was a very vast area disaster and also it was a complicated one. That was why it had long-term impacts. At the very beginning, WHO was aware of that. We had temporary houses which were required for many people. These houses were needed over a vast area and many people had to live there for an extended time period. That had big psychosocial impact. And also, there was fear and uncertainty. We also had nuclear power plant accidents.



At the time of Chernobyl, that was under the control of the Communist government of Soviet Union. Data were not disclosed. And also, Nagasaki-Hiroshima nuclear bomb, these data were not very much made available because it was what happened during the war. So, this Fukushima Nuclear Power Plant was virtually the first in human history in which we were able to have data and this data was disclosed to the public. So there was a great level of uncertainty and fear associated with that and also PSND management, elderly care, and continuity was tested.

Twenty years have passed since Great Hanshin-Awaji Earthquake. This is the 21st year. We have still reconstruction houses in Kobe. In the past 20 years, some people became independent obtaining jobs and left the houses. However, there are still a handful of people who still remain there who do not have many means to live. Even in Kobe city, it is a big problem.

Twenty years ago these people in their 50s and came to temporary houses. They lost everything. Now they are 70 years ago; or 20 years ago, 60 years old and currently 80 years old. They were low income people and they lost job and they still didn't have job. Twenty years after that still they are impoverished and they cannot leave the temporary houses. And that still exists in Kobe. So we can learn something out of that.

This is statistics for Great East Japan Earthquake as you know. The death 175,000, missing 2848, injured 6109 as of 2012 August 8th. Sixty-five percent of the dead were 60 years and older and also the socially valuable, they had higher mortality and there were differences in regions. Also, this is PSND. This is abbreviation of persons with special needs at times of disaster. There were no shelters that were adequate for them. And also, disaster related secondary deaths were a problem. So, this disaster was of vast area and very complicated. That was why there were many mid-to-long term impacts which came out of the disaster.

What can we learn from East Japan earthquake in terms of health? Mental health and psychosocial support are needed. And also, we talked about vulnerable populations and we tend to think of pregnant women and children. Of course these people are important but in addition to that the elderly and persons with disabilities we shouldn't forget the care for them.

Also medical institutions, how can we maintain them? Just as the safe hospital guide I mentioned, we need to first reconsider. Also, this is not just the WHO but Japanese government is reviewing the DEMAT system. And because we have reviewed them, in Kumamoto DEMAT is very much active.

And also, the logistics were a big problem. Just as Mr. Tachiya, Mayor of Soma city mentioned, many things would stop at a time of disaster. So, what things would be stopped and how can we ensure these necessities to be obtained. That's what we will have to think about.

Lessons from GEJE for health



- Mental health and psychosocial support
- Care of the Elderly
- Care of the persons with disabilities
- Business continuity plans for the health organizations and facilities
- Review of DMAT system
- Disaster reference hospitals
- Logistics management for health response
- Governance: national and local coordination and collaboration

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And in the case of Kumamoto, there are many things that can be considered. But in WHO, in the past 10 days to 2 weeks, in spite of the scale of the Kumamoto earthquake disaster, in the space of 10 days, Shinkansen were reconnected and so were the national highways. We praise these efforts with an awe. I believe that I think that that was a lesson learned from the great East Japan earthquake and also the governance, nationwide and local coordination and collaboration were deemed necessary.

Health security and health emergencies, there are many events and there are so many events to list up. We have to actually consider our preparedness for all hazards at WHO. We don't limit our responsibility only to the natural hazard or natural disaster but all the possible hazards and risks should be actually captured and also taken care of.

Our targets are always the vulnerable people. There are common people everywhere in the world. And also that accidents

Nature of health security & health emergency events...

- **All hazards:** communicable disease outbreaks; natural disasters
- Vulnerability is *universal*
- *Frequency* of events increasing
- **Impacts** are far beyond "cases & deaths" (often huge economic, social and political consequences)
- Emerging disease *travels faster* than ever before
- Fear *spreads quicker* than disease itself
- *Long term* psycho-social impacts

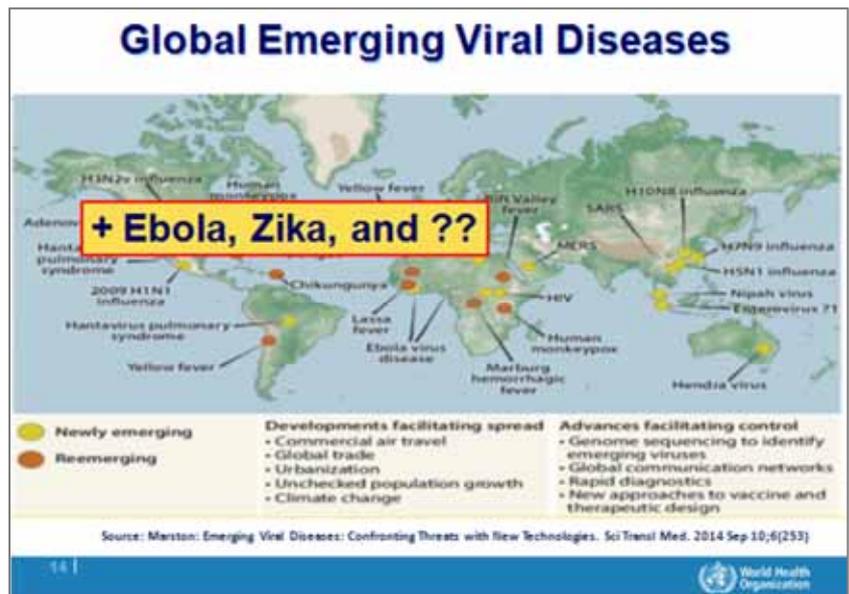


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and events too take place so frequently now-a-days, we have to be aware of that. And casualties, death tolls and others are increasing. But not only that, the economic and political impact had to be also considered. So, more than ever, a single disaster can cause so much damage and losses, and those damages and losses are really large in scale and also complex.

And also that the emerging diseases and disaster impact travel faster than ever before, like communicable diseases and pandemics are travelling faster. Disaster itself and pandemics or the communicable diseases spread a fear, actually it is really fast because of the globalization and also technology advancement and use of social media like SMS and others, so fears and worries actually spread quicker than actual disease spread. Then social impacts have to be considered in long-term basis and these are the learnings from the past experiences of disasters.

In 1980-2016, if I am to pick up the health security incidents, have AIDS and Chernobyl and past and NvCJD and Nipah and Anthrax and SARS and meningitis and cholera and Animal Flu and Fukushima disaster, the nuclear accident, MERS, polio or e-coli, dengue, H71 and environmental contamination and pollution just to name a few, and recently Ebola and Zika. Almost every year, we have some kind of outbreak which really gives the impact to the health security.



WHO is focusing on the global health and security, we have the very important role to fight against the emerging viral diseases. And as you can see from the world atlas, there are so many outbreaks of new diseases in the past few years. Ebola in 2014, and last year and this year Zika, and I am sure that the new threat will emerge. In 1970s and 2007, 1420 new pathogens made news, and 2007 onwards, we had 177 new pathogens, 70% of which are derived from animals, animal origin.

This is Ebola virus. In 2014, the outbreak of Ebola fever, like Guinea, Sierra Leone, and Liberia, those three nations, pandemic emerged, and actually epicenter is somewhere around here. But other than three nations, no pandemic took place, or there effective containment was made. As for the damage, more than 11,000 dead and 29,000 affected, 10 countries and three continents were affected including capital cities. And some nations made a decision to close their borders. Liberia, Guinea, and Sierra Leone, other than those three nations, containment was successfully conducted. So in a short period of time, the problem was resolved.

Recently, the issue of Zika in conjunction with the microcephalus reported from South America, 2016 February, international declaration was made that the PHEIC was actually issued. PHEIC was the internationally concerned the public health emergency situation. This declaration which I would like to touch up later to share with you some detailed information.

Zika fever and epidemic of microcephalus and neurological disorders

- On February 2016, WHO declared 'Public Health Emergency of International Concern' in response to the sharply increasing cases of microcephalus and neurological disorders, suggesting association of the cases with Zika virus infection (Usually reported cases of microcephalus was about 160 cases/year, but 4000 cases were reported within 8 months.)
- Zika virus rapidly spread along with the habitat range of *Aedes mosquitoes*. Until 2014, 36 countries reported cases of Zika virus infection. The infection is predicted to continuously expand across the entire globe.

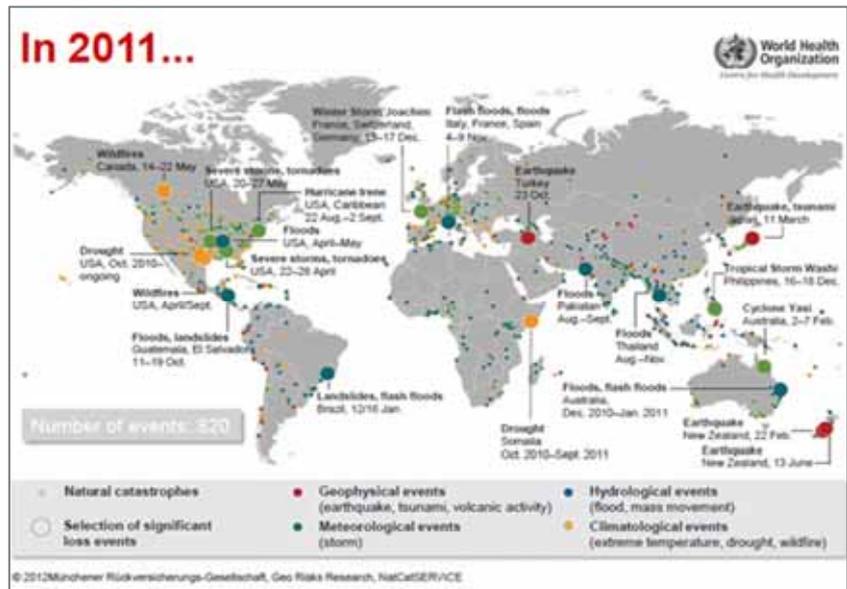
Now, this one is the global cases of MERS which took place recently, MERS coming very strong in China

or Korea, Malaysia, Thailand, and Asian nations. And as been reported that the spread of this disease in animal was in 2015 last year, the MERS cases was actually observed in Korea and we Japanese people were so concerned perhaps that the epidemic will come to Japan.

A new type of influenza, H1N1 data, they were reported to the WHO. We had so many cases in the world. And death toll was also reported. Influenza had different strains and different type of flu pandemics are introduced in the world.

Only in 2011, this one year only, this is a natural disaster, natural disaster that took place in the one year of 2011.

From the year 2012, disasters had so much serious impacts which really had a damage of \$1.7 trillion and 2.9 billion people were affected by the disasters and those disasters took 1.2 million lives. Also the climate change related diseases, 3400, floods; 2689, storms; 470, droughts; 395 extreme temperatures, just to name a few. UNISDR the United Nations agency with regard to climate change received those reports. And there are so many challenges: the population explosion, drain of population, and urbanization and concentration population to the urban cities.



The urbanization and health problem or in short urban health problem is becoming very predominant. And also, along with advancement of technology or transportation means that people's mobility is accelerated and the communicable diseases to attack human beings.

All those challenges, the hazards and disasters, the health risk is increasing its magnitude. And whether we are able to mitigate those risks is our challenge and our mission. Those disasters so much impact the death of people, psychosocial stress, possible environmental pollution, exposure to toxic substances, and all those factors are very much complex. As for the outbreak of the communicable diseases caused so much economic losses, as huge as you can see from those numbers in this atlas, so from which we have a lot to learn from. Like 2014, the outbreak of Ebola, the fear actually spread faster than the actual disease and caused so much economic losses or damages.



The new planning issues we have to actually deal with, be that the communicable diseases so the natural disasters, we should build resilient health systems and maintain that system. And also to backup that, healthcare financial system has to be made. In 2014, Ebola outbreak case which I mentioned, in three nations, contamination – spread because of the inability or the vulnerability of their healthcare system is criticized.

Physicians and medical institutions are not sufficient, or the healthcare professionals are very few in number; that caused the spread out the pandemic. The situation is exactly the same with disaster. Disasters, you have to actually make sure that preparedness and prevention to deal with disasters. And then, there are chronic diseases in elderly people, people with disabilities, people who are socially weak have to be taken care and consideration and also the continuation of care provided to the evacuees or the people who are displaced, and also that long-term psychosocial impact to people should also be considered. Out of those bitter experiences in the past, we have so much learning.

As for the recovery as is written down in this slide, long-term impact is very serious on survivors. Sometimes it is overlooked and not enough research or implementation. As for the humanitarian activities, in regard to the development activities and also the confrontation between national government and local government, inability to have communication and sharing information, that kind of issue has to be discussed and resolved.

But there are good points, the bright side to it. Because of the information revolution and biotechnology revolution and also communicable diseases actually to – we actually fought for that communicable diseases and set up the international health regulation in 2005. And Sendai Framework for the disaster risk reduction was adapted in the United Nation's Congress for the disaster risk reduction took place in Sendai in 2015. The first and second and third UN Congress was held in Japan, Yokohama, Kobe, and Sendai last year. In Yokohama, the action plan was formulated, followed by the Hyogo action framework, and then in Sendai, there's another brush-up in the development of the framework declared in Sendai for the realization of disaster risk deduction.

Now, WHO has a role to play. An international health regulation was issued and around that international health regulation, those collaborations and teamwork with various other agencies outside the health issues are agriculture issues and transportation agencies. In other safety security and telecommunication, we should actually have the holistic picture in joint collaboration with other parties. And based on that international health rules, we should continue the implementations and monitoring of the health security.

International Health Regulations (2005)

- Legally binding treaty** • 
- 196 States Parties** •
- In force 15 June 2007** •

States must prepare, report & cooperate

WHO must coordinate





Health systems + UHC = resilience

- UHC = all people have access to quality health services without financial hardship linking individual and population security.
- Reinforce health systems to ensure UHC and emergency preparedness/health security
- Manage unpredictability of events = lack of resources and attention
 - Raise political attention to IHR, Hyogo/Sendai Frameworks
- Connect different sectors, communities, families, and individuals to achieve UHC

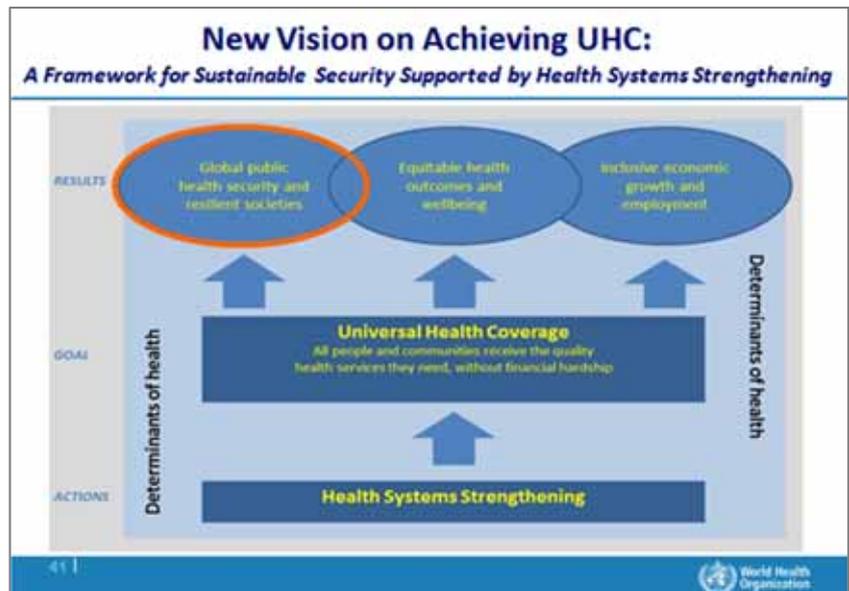


International health regulation is a kind of agreement, a convention with 196 member countries to sign. And effective in 2008, the revised IHR was issued. And the signers, the signatory countries follow the stipulations and requirements in IHR to deal with the communicable disease possible for the outbreak and make the preparations and cooperation. And WHO is playing the role as a coordinator among those member nations or the signatory nations.

I just mentioned Ebola fever, resilient health system should be established or built and also to be maintained. That is emphasized in the international health rules, and that the continued discussion is underway. In WHO, we have emergency refill agenda and universal health coverage agenda, so that we are able to fortify the health system. This is one of the very important projects that we are running at WHO. This is a new schematic diagrams and concept of the project. This could be the outcome. To create a resilient society, we should actually implement universal health coverage and other fundamentals. You have to actually strengthen the medical system of each and every nation. That is a kind of first step to move forward.

Based on that, we would actually have to strengthen the health system nations through the ideas of universal health coverage so that we are able to actually establish and maintain a resilient health system and resilient society.

Now into the future, however that we are able to manage the disasters and diseases and various other emergencies, we have to stick to the IHR and also the evidences should be collected through various researches and surveys. In WHO, we have new WHO health emergency program, it is now being formulated and OCHA has formulated that international health emergency processes.



Out of the experience of Ebola fever, we have come up with the idea that we should come up with some kind of financial fund so that we are able to immediately dispatch the specialist team at the time of disaster and emergency, so this is a contingency fund for emergencies and World Bank also have the pandemic emergency Financing Facility.

As I just mentioned, there are many endeavors and activities going on. Please visit our website for further information. With this, I would like to conclude my presentation. Thank you very much indeed for your attention.

The Minamisoma Babies Study: Health at Birth in the Four Years Following the 3.11 Triple Disaster

Claire Leppold Minamisoma Municipal General Hospital, Researcher



Hi everyone.
As Shibuya-sensei said, my name is Claire Leppold and I work in the research department of Minamisōma Municipal General Hospital. Today, I would like to present the results of my study on health at birth in the 4 years following the disaster. These findings are from my paper that is currently under review at BMJ Open; because it is still under review, it should be considered a work in progress.

I'm going to start with a reminder that maternal and perinatal health are two very important parts of general public health. If the mothers and babies in a population aren't healthy and well, this can have devastating effects on everyone. So to maintain and improve public health, these two groups are crucial.

Unfortunately, disasters can lead to negative health effects on everyone, and women may be particularly vulnerable in these situations. Previous research suggests that women, especially during pregnancy or when they have young children, are at increased risk of negative health outcomes in the aftermath of disasters, and this of course can have implications for the health of their children as well.

One phenomenon that has been observed after previous disasters is that there have been significant increases in the rates of low birth weight and pre-term births. It is thought that the reason for this is either through environmental exposures, as in exposure to a toxin, or psychological stress as a result of the disaster. And while most previous studies have focused on women who were pregnant at the time of a disaster, there is also evidence that these changes in population of birth outcomes can continue for years following the actual disaster.

You may look at this and wonder, why would changed rates of preterm birth and low birth-weight births be important? But the answer is actually quite interesting. There is a lot of previous research that suggests that weight at birth especially, but also gestational age at birth, can predict the long-term and short-term health of this child. Of course, weight at birth and gestational age at birth reflect the

Maternal and perinatal health in disaster settings

Natural disasters, chemical disasters, terrorism, humanitarian emergencies may lead to...



- Loss of access to healthcare
- Disruption of water, food supplies, shelter
- Injury, disease, death
- Possible introduction of environmental toxins
- Psychological stress

wellbeing of the mother as well, but they also hold key hints, like I just said, about the long-term health of newborns.

A wealth of interesting research has been conducted on this subject and it's been found that both of these factors (low birthweight and preterm birth) can independently predict mortality in the first year of life but also disease in adulthood. For example, low birthweight of less than 2500 grams is associated with increased risk of diabetes, of cardiovascular disease, of other non-communicable diseases in adulthood, which brings about the question, if disasters can change rates of preterm birth and low birthweight births in populations, does this have any long-lasting implications for the health risks of this population or the long-term health of new generations?

Birth outcomes in the aftermath of disasters

Significant increases in low birthweight births and/or preterm births have been observed after disasters, hypothesized to be caused by environmental exposures or psychological stress [1,2]



Observed increases in low birthweight may continue for years post-disaster [3]

As the entire theme of this conference suggests, we are standing in an area that was significantly affected by three disasters. The 3/11 triple disaster immediately led to damage, mostly from the earthquake and tsunami, but the long-term effects of the nuclear disaster have been particularly profound. And we have seen continuing evacuation, changing lifestyles, changing health risks and a host of mental health problems including radiation-related anxiety. So when we look at the picture of what has happened here and what is continuing to happen here after this disaster, we can wonder have there been any impacts on the health of those born in affected areas, and this was the question that I had.

I was able to find two previous studies that also asked this same question. These studies both looked at birth outcomes in the first year after the disaster. One looked at Fukushima prefecture and compared incidence rates of multiple birth outcomes to national averages at the same time, and they could find no significant differences including pre-term birth and low birthrate. Another study looked at earthquake affected areas in Tohoku compared to non-affected areas in the rest of Japan; and again, they found similar rates of low birth rates and preterm births.

While these studies both have their limitations and they are only in the first year after the disaster, this is actually quite interesting in itself because this is so different than what has been observed after other disasters. After Hurricane Katrina or after the 2007 earthquake in China, there were immediately shifts in population rates of low birth rate and preterm births that could be picked up in research. So, to see these results is really interesting and surprising and I immediately wanted to know what the long-term trends looked like. In this way the Minamisoma baby study was born.

We decided to look at maternal and neonatal characteristics of all the births in our hospital from 2008 to 2015, and our objectives were to first see if there had been any long-term changes in preterm birth and low birthweight birth rates but also to see if there are any associations between evacuation and food avoidance and birth outcomes.

I thought I would clarify the study location for those who might not know. Minamisoma Municipal General Hospital is located 23 kilometers away from the nuclear power plant and it borders multiple evacuation areas. As Hayano-sensei explained really nicely in his earlier presentation, the 20-kilometer radius of the power plant was immediately designated as a mandatory evacuation zone after the disaster, and the 20-30 kilometer radius was first an indoor sheltering zone but it became a voluntary evacuation zone, and this includes our hospital.

Of course the zones have changed a lot in recent years. The mandatory zone has expanded to include some mountainous areas but it's also re-opened for residency in some places the south. The main point of this is to just show you that our hospital borders multiple evacuation areas and it serves places that have been significantly affected by all of these disasters.

For our methods, we looked at all live singleton births from 2008-2015 and we picked up this information from patient records on maternal characteristics and neonatal characteristics of every birth. We also classified all of the post-disaster participants based on their residential address at the time of the disaster to try and estimate whether they had evacuated or not, or whether they were forced to evacuate or not. For the pre-disaster mothers, we also put them into the same groups based on their residential address at the time of birth, just to make sure that there were no underlying trends by area.

We also used data from the whole body counter screening program. As Hayano-sensei said, whole body counter screening is a screening for internal radiation contamination; but at the time of the screening they also give a questionnaire which asks how you acquire your food products. We had a hypothesis that avoiding Fukushima food products could be indicative of radiation-related anxiety. Anxiety fits together with psychological stress, which is known to affect birth outcomes, and we thought this could have been a factor contributing to any of the outcomes in our study. So, for all of the post-disaster mothers who did whole body counter screening – and this happens in our hospital for free and all women are encouraged to undergo this screening during their pregnancies -- we picked up their data on food choices as well.

The Minamisoma Babies Study

Investigation of maternal and neonatal characteristics before and after the 2011 Fukushima nuclear disaster through a study of all births at Minamisoma Municipal General Hospital from 2008-2015.

Objectives:

1) To assess if there were long-term changes in birth outcomes in Minamisoma City following the Fukushima nuclear disaster, in comparison with pre-disaster baseline data.

2) To evaluate if post-disaster birth outcomes were associated with evacuation or food avoidance.

Maternal and Neonatal characteristics by year (n, %)

| | Baseline | 2012 | 2013 | 2014 | P-value of test for percentage difference |
|-----------------------------------|------------|-----------|------------|------------|---|
| Birthweight | | | | | 0.01** |
| <2500 | 44 (7.6) | 5 (5.6) | 10 (6.2) | 17 (9.6) | |
| ≥2500 | 533 (92.4) | 85 (94.4) | 152 (93.8) | 161 (90.5) | |
| Gestational age | | | | | 0.39** |
| Fullterm | 547 (94.8) | 88 (97.8) | 153 (94.4) | 173 (97.2) | |
| Preterm | 30 (5.2) | 2 (2.2) | 9 (5.6) | 5 (2.8) | |
| Sex of neonate | | | | | 0.57* |
| Male | 291 (50.8) | 40 (44.9) | 77 (47.8) | 94 (53.1) | |
| Female | 282 (49.2) | 49 (55.1) | 84 (52.2) | 83 (46.9) | |
| Delivery mode | | | | | 0.32* |
| Vaginal delivery | 449 (77.8) | 75 (83.3) | 123 (75.9) | 131 (73.6) | |
| Caesarean section | 128 (22.2) | 15 (16.7) | 39 (24.1) | 47 (26.4) | |
| Maternal age at delivery | | | | | 0.05* |
| <35 | 480 (83.2) | 67 (74.4) | 122 (75.3) | 143 (79.2) | |
| ≥35 | 97 (16.8) | 23 (25.6) | 40 (24.7) | 37 (20.8) | |
| Number of prior-deliveries | | | | | <0.001* |
| 0 | 214 (37.1) | 34 (37.8) | 74 (45.7) | 97 (54.5) | |
| 1 | 160 (29.1) | 39 (43.3) | 59 (36.4) | 52 (29.2) | |
| More than 2 | 195 (33.8) | 17 (18.9) | 29 (17.9) | 29 (16.3) | |

Interpretation

- No significant change in prevalence of preterm birth or low birthweight following the disaster.
- Significant increase in the proportion of older mothers (delivery at age >35 years) ($p=0.05$) and first-time mothers ($p<0.001$).

* Chi-squared test ** Fisher's exact test

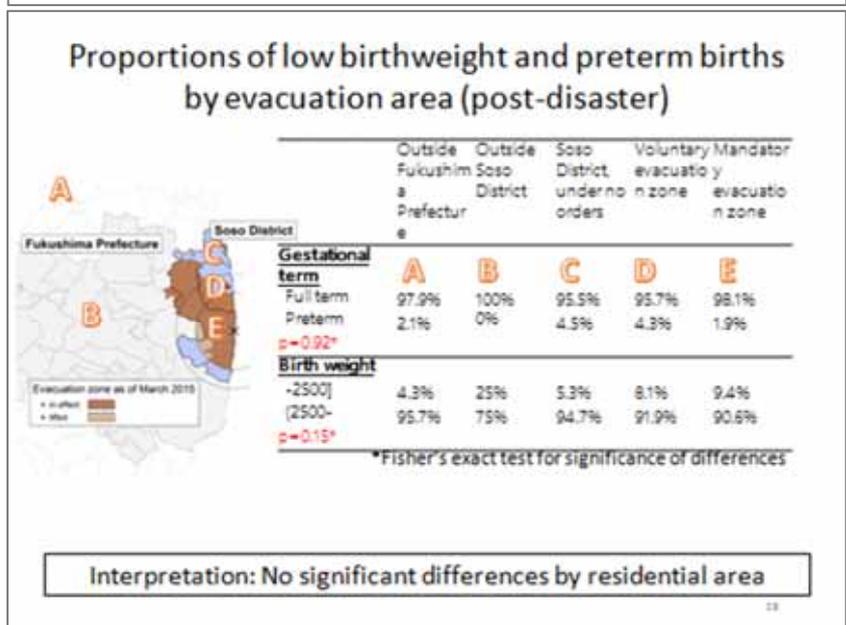
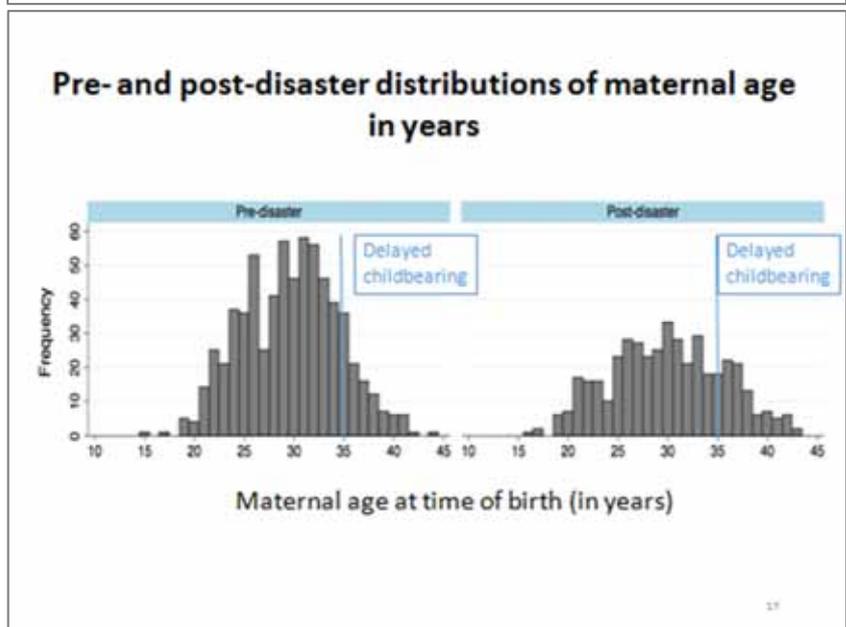
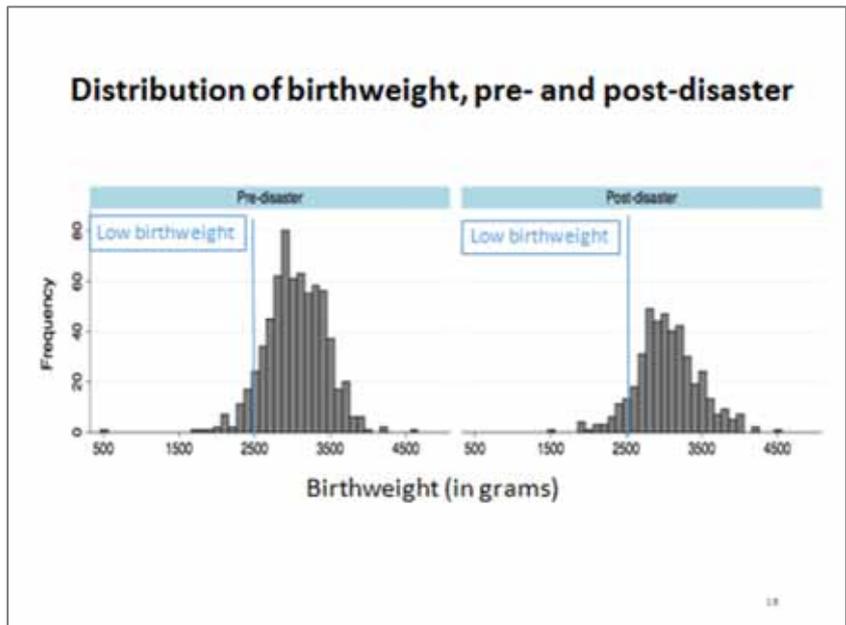
For our analyses, we first simply looked at the prevalence of pre-term birth and low birthweight births in each post-disaster year compared to the pre-disaster baseline. We also calculated weight ratios to see if there was any increased risk of these outcomes after the disaster, and we also just simply looked if there were any associations between evacuation and food choices and the two outcomes.

So these are our results. Overall, there were 1101 live births in the

study years. We found that 93% of the post disaster mothers went through whole body counter screenings, which is really great. And most significantly, from demographic characteristics, we understood that there were no significant changes in the prevalence of low birth rate and preterm births in pre and post disaster periods.

This table shows the demographics of our study population and you can see the prevalence of low birthrate and preterm births, and the lack of any significant differences by year. You also might be able to notice that there were some interesting changes in maternal demographics. We unexpectedly found that the proportions of older mothers over age 35 and first-time mothers increased after the disaster. This table is probably difficult to look at and I apologize for that, the next one is hopefully a bit easier.

This shows the distribution of birth rate in pre and post disaster periods. And again, there were no significant changes in the proportions of low birth rate. Of course, the numbers of birth themselves decreased after



the disaster probably due to evacuation or population changes; but again, the proportion of low births itself did not significantly change.

On the other hand, this is the distribution of maternal age. You can see it got a lot flatter after the disaster. Before the disaster, the majority of births were to mothers between the ages of 25 and 35, but this age group really shrunk after the disaster. Again, we think this is probably due to evacuation of young mothers especially. But you can see that the proportions of older mothers over age 35 therefore increased overall after the disaster. In our risk rate ratios, we again could find no significantly increased risk of pre-term birth or low birthweight birth after the disaster.

Again, we coded people by their residential address at the time of the disaster to look for evacuation but we still could find no significant associations between evacuation zones and birth outcomes. We also ran this through a regression model and adjusted for factors such as sex of the neonate and age of the mothers and still could find no significant associations. This suggests that evacuation was not associated with preterm birth or low birthweight birth.

For food choices, we also could find no associations between food choices and birth outcomes. And again, we ran this through a regression model and still could find no significant associations. This suggests that regardless of whether you were going to the store and avoiding Fukushima products or if you were directly using a farm in Fukushima, there were no significant associations with the birth outcomes.

In summary, we could find no significant increases in the prevalence of pre-term birth or low birthweight births after the disaster, and no significant associations with evacuation or food avoidance. But we unexpectedly did find an increase in the proportions of older mothers over age 35 and first time mothers after the disaster.

Proportions of low birthweight and preterm birth by food purchasing habits (post-disaster)

| | A | B | C | D | P-value |
|-------------------------------|-----------|------------|-----------|-----------|---------|
| Preterm birth | | | | | |
| Rice | 7 (3.1%) | 1 (1.6%) | 4 (4.6%) | 0 | 0.72 |
| Meat | 7 (2.8%) | 5 (3.6%) | 0 | 0 | 0.76 |
| Fish | 7 (2.5%) | 5 (4.9%) | 0 | 0 | 0.36 |
| Vegetables/fruits | 8 (3.4%) | 3 (3.4%) | 0 | 0 | 1.00 |
| Mushroom | 7 (2.6%) | 5 (4.3%) | 0 | 0 | 0.36 |
| Milk | 7 (3.1%) | 5 (3.2%) | 0 | 0 | 1.00 |
| Low-birth weight birth | | | | | |
| Rice | 19 (8.5%) | 4 (6.5%) | 5 (5.7%) | 1 (16.7%) | 0.55 |
| Meat | 16 (6.4%) | 13 (9.4%) | 0 | 0 | 0.31 |
| Fish | 18 (6.3%) | 11 (10.8%) | 0 | 0 | 0.30 |
| Vegetables/fruits | 16 (6.7%) | 8 (9.0%) | 2 (10.0%) | 0 | 0.72 |
| Mushroom | 19 (7.0%) | 10 (8.6%) | 0 | 0 | 0.67 |
| Milk | 16 (7.1%) | 12 (7.7%) | 0 | 1 (100%) | 0.14 |

A: (Supermarket)
Selection based on origin (Fukushima vs. non-Fukushima)

B: (Supermarket)
No consideration of origin

C: Using local farms or homegrown foods with radiation inspection

D: Using local farms or homegrown foods without radiation inspection

Interpretation: No significant differences between food purchasing habits and low birthweight and preterm birth outcomes //

I think the natural response to hearing results like these is “why,” and of course we asked ourselves this same question when we saw the results. These are again really different from what has been seen after other disasters and it’s quite interesting to think, how did this happen and why are we not seeing significant changes in Fukushima? I thought perhaps we could look at the reasons why it’s proposed that there have been changes in other disaster settings, and to put those reasons in the context of Fukushima to try and think about why we might not have seen changes here.

As I said, in the beginning of this presentation, the two main hypothesized pathways from disasters to changes in population birth outcomes are either psychological stress or environmental exposures. A really good example of an environmental exposure is the love canal accident which happened in the US. It was a toxic waste dumping and one neighborhood was reaffected by exposure to toxic waste, and it was found that after this accident there were dramatic increases in low birthweight and birth defects in affected populations.

After Chernobyl, it was similarly a concern whether radiation exposure would have had any effects on pregnant mothers. There's really mixed evidence for Chernobyl. While some studies do suggest increases in birth defects, others generally don't, and there have been no significant indications of any changes in birthweight or preterm birth rates. Most reviews that I read of Chernobyl concluded that there was little effect on most pregnancies. So in general, there's mixed evidence for environmental exposures, but it still remains a majorly hypothesized pathway from disasters to changes in population birth outcomes and there have been countless studies on this topic.

The other main hypothesized pathway is psychological stress, and most earthquake studies have hypothesized that this is the reason why they found changes in birth weight after earthquakes. Some studies directly ask mothers "did you feel stressed after this earthquake?" or "how much stress did you feel?" while others just classify people based on where they are living, but there are a significant number of studies that find changes after earthquakes using this reasoning.

I think a really good example of this is the Swedish ferry accident. 500 people were killed in an accident when a ferry sank in Sweden. Subsequently, there was a 15% increase in very low birthweight births in the national population of Sweden. This is really interesting because it suggests that even if you don't directly experience a disaster, so even if you don't feel the shaking of an earthquake or you are not on the boat that's sinking, you can still feel grief over these events which may in turn affect your health or the health of your children.

We can try and put these two pathways in the context of Fukushima. If we start with environmental exposures, a lot of people assume that because there is a nuclear disaster here, radiation exposure would be the biggest pathway to population health changes. But we are finding that this perspective is not so accurate. As I just mentioned about Chernobyl, there is overall really mixed results coming out of studies, but most reviews conclude there was little effect on most pregnancies. It is also important to remember that the scale of disaster is different between Chernobyl and Fukushima. The United Nations Scientific Committee on the effects of atomic radiation have actually predicted no significant effects of radiation exposure on fetal outcomes in Fukushima.

It's also worth noting that in the present study, out of all the post disaster mothers who underwent whole body counter screening, none of them had detectable levels of internal radiation contamination (cesium).

So, all of this information suggests that in our study it would be very unlikely that radiation exposure would have had any effects on the outcomes. However, psychological stress is still another big concern, and after Chernobyl, it was found that actually radiation-related anxiety, not the radiation itself, was associated with earlier births.

We were also concerned about this in Fukushima. As I said earlier, there has really been continued evacuation and changes in the lives of residents here, and we thought that this could have contributed to psychological stress. We also know from previous studies that in disaster settings, women may be more susceptible to feeling high levels of stress than men. There's also growing research on stress and birth outcomes in non-disaster settings, so general settings, finding that stressful life events prior to conception are associated with low birthweight births later in life. This suggests that stress you feel before you are even pregnant may have effects on your later births.

To take account for all of these factors, we tried to capture any possible pathways from the disaster to stress to health effects by categorizing our participants based on evacuation and food avoidance. And to look for any long-term effects, we included all the births up until 2015. But again, we could still find no changes in the rates of preterm births or low birthweight births. This result is quite perplexing because it's difficult to say, really impossible to say, that mothers in Fukushima felt not stress after this

disaster. We can't say that. Which leads us to wonder, in this situation with a huge potential for stress, why did we see no apparent effects of stress on health outcomes? This point leads us into further discussion.

The results of this research suggest that a disaster in and of itself may not lead to population level changes in birth outcomes. And this is really a call for further research. We really need to know what the exact factors are that lead from disasters to changes in health outcomes. In particular, I am curious if could there be any factors that may exacerbate or protect against the effects of disaster-induced stress. Some of my other questions are: are there any other factors that may make people who experience stress less likely to experience or be hit by the negative health implications of it? Are there any community or structural factors that could mediate effects of stress on health? And while our research doesn't have the answer to all of these questions, I think it can rather be thought of as a springboard for future studies on birth outcomes in disaster settings but also stress and birth outcomes even in non-disaster settings.

To close, we'd like to leave you with the following messages. To mothers and families in Fukushima, after this disaster we could find no significant increases in the prevalence of low birthweight or preterm births, and no effects of evacuation or food avoidance. To scientists, our data suggests that disasters did not necessarily result in changes in population level birth outcomes. This is a point that needs further research. And to the general public, we have found that health at birth in our hospital located 23-kilometers from the power plant did not significantly change after the disaster. We are surprised by this result but we find it to be something worth celebrating.

This study would have been impossible to do alone, and I am greatly thankful for the help and support of the people listed here. In particular, I would like to thank Dr. Hiroshi Anbe who has been the only Ob-Gyn in our hospital since the disaster. The health and safety of these babies is really thanks to him.

Messages

- To mothers and families:

In this study we saw no significant changes in low birthweight or preterm births after the 3.11 triple disaster, and no effects of evacuation and food avoidance on these outcomes.

- To scientists:

Our data suggests that disasters do not always result in population level changes in birth outcomes, presenting a need for further research.

- To the general public:

Birth outcomes at Minamisoma Municipal General Hospital, located 23km from Fukushima Daiichi Nuclear Power Plant, did not appear to change after the disaster. We are surprised by this result, but find it to be something worth celebrating.

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