Economics and Human Biology 21 (2016) 110–121

Contents lists available at ScienceDirect

Economics and Human Biology

journal homepage: http://www.elsevier.com/locate/ehb

Impact of the Fukushima nuclear accident on obesity of children in Japan (2008–2014)

Eiji Yamamura *

Department of Economics, Seinan Gakuin University, 6-2-92 Nishijin, Sawara-ku , Fukuoka 814-8511, Japan

ARTICLE INFO

Article history:
Received 26 September 2015
Received in revised form 5 January 2016
Accepted 7 January 2016
Available online 14 January 2016

Keywords:
Fukushima
Nuclear accident
Body mass index
Obesity

ABSTRACT

This study used prefecture-level panel data from Japan for the period 2008–2014 to investigate the influence of the 2011 Fukushima nuclear accident on the body mass index (BMI) *z*-score and obesity rates of children over time. I adopted a difference-in-differences approach and found the following: (1) for the cohort aged 5–7 years in 2010, the BMI *z*-score and obesity rates in disaster-affected areas were higher than in other areas, although this was not observed for the other cohorts; (2) for the cohort aged 5–7 years in 2010, the influence of the accident persisted even after 3 years; and (3) the differences in the BMI *z*-score and obesity rate before and after the accident were greater for Fukushima Prefecture than for the other affected areas (Iwate and Miyagi prefectures). I infer that health-conscious parents, whose children had lower BMIs, may have moved from Fukushima, thereby increasing the BMI *z*-score of the child population living in Fukushima by around 0.05 for the cohort aged 5–7 years. The enforced reduction in physical activity increased the BMI *z*-score of children living in Fukushima by around 0.19 for that cohort.

1. Introduction

On March 11, 2011, Japan was struck by a large-scale natural disaster, combining both an earthquake and tsunami. These damaged the Fukushima Daiichi Nuclear Power Plant, located on the coast of Fukushima Prefecture in northeast Japan. A level-7 nuclear disaster rating was assigned—a level previously reached only once, in the Chernobyl disaster. Inevitably, Fukushima's residents had to deal with the danger of radiation exposure, and a number of people left the area (Japan Times, 2012; Matsuda et al., 2015).

The Great East Japan Earthquake and Fukushima nuclear accident had a substantial impact on economic conditions (Ando and Kimura, 2012; Hayashi, 2012) and happiness levels (Uchida et al., 2014; Rehdanz et al., 2015; Yamamura et al., 2015) in Japan. According to media reports, the nuclear accident led to "a lack of physical exercise and stress stemming from prolonged living in shelters and restrictions on playing outside" (Yomiuri, 2012). Consequently, "an alarming trend toward obesity has been found among children in Fukushima Prefecture, which has the highest rate of obese children in every age group between 5 and 9 years old" (Yomiuri, 2012)[1]. Studies that have assessed other nuclear accidents, such as Three Mile Island and Chernobyl, provide evidence that nuclear accidents have both short- and long-term detrimental effects on

* Tel.: +81 92 823 4543; fax: +81 92 823 2506.
E-mail address: yamaei@seinan-gu.ac.jp

[1] In addition to Fukushima Prefecture, children in Miyagi and Iwate prefectures had high obesity levels (Yomiuri, 2012).

http://dx.doi.org/10.1016/j.ehb.2016.01.001
1570-677X/

human lives[2]. However, little is known about how and to what extent the Fukushima accident has affected body mass index (BMI) *z*-scores and changes in obesity rates. Overweight children are thought to have a higher risk of developing various diseases in later life. This raises the possibility that the Fukushima accident has indirectly influenced residents' health status through rising obesity. It is therefore important to assess the effect of the Fukushima accident on children's physical condition. The present study draws on prefecture-level panel data covering 2008–2014 and uses a difference-in-differences approach to assess the long-term effect of the nuclear accident on the BMI *z*-score and obesity rate of children in Japan.

Section 2 of this paper provides an overview of the data and empirical method. Section 3 presents and discusses the major findings. The final section offers conclusions.

2. Data and methods

2.1. Data

The Japanese Ministry of Education, Culture, Sports, Science and Technology conducts the School Basic Survey across the country annually. This survey collects data on the height, weight, and obesity rate of school-aged children. Japan comprises 47 prefectures, and the ministry releases the average heights and weights for each. Height and weight data are further broken down for boys and girls between the ages of 5 and 17 years.

This study adopted a difference-in-differences method using data from the period 2008–2014. The sample areas (those affected in the 2011 disaster) were Fukushima, Iwate, and Miyagi prefectures because the Great East Japan Earthquake directly affected them[3]. Data from those three prefectures were not collected in 2011 because of the impact of the disaster. To assess the effect of the Fukushima accident on young children over time, I conducted my estimations using cohort groups. The composition of the dataset used in this study appears in Table 1.

I used BMI as a measure of overweight. That measure is flawed because it ignores the distinction between fat and muscle (Burkhauser and Cawley, 2008), and so physical activity that builds muscle and burns fat will have an ambiguous effect on BMI. However, Cawley et al. (2013) argued that this factor is less relevant in the case of elementary school students, whose physical activity involves less muscle-building exercise and who are less prone than adolescents are to adding muscle mass. Younger children are more likely to be influenced by their social circumstances than older ones, so I focused on children aged under 10 years. I divided the data used in this analysis into three cohort groups according to the children's age in 2010: 5–7, 8–10, and 11–17 years. For example, the same cohort included children who were 7 years old in 2010 and 9, 10, and 11 years old in 2012, 2013, and 2014, respectively. Separate data were obtainable for boys and girls. The sample sizes differed slightly among the cohorts because of data availability.

I calculated the average BMI values, which reflect the average level of overweight and obese children in each cohort, but may have been influenced by outliers in the sample. To control for this phenomenon, some studies have used the BMI *z*-score, which is standardized by age-specific BMI averages (Cawley et al., 2013; Inokuchi et al., 2011). Therefore, I also calculated the BMI *z*-score based on the mean BMI values and standard deviations for each age (Inokuchi et al., 2007). The method of calculation for the BMI *z*-score appears in Table 2. As shown in Table 3, the BMI *z*-score – unlike the BMI – does not increase with children's age. Using the BMI *z*-score therefore allows a comparison of the obesity rates among different age-groups. I also assessed the obesity rate to determine the robustness of the BMI *z*-score data. The obesity rate is defined in Table 2. My focus in this study was on the BMI *z*-score and obesity rates from 2008 to 2014, and I compared them between disaster-affected and other areas.

Fig. 1 shows how the difference between the average BMI *z*-score in disaster-affected and other areas changed from 2008 to 2014 for each cohort. Throughout the study period, the difference in the BMI *z*-score was consistently greater than 0. This implies that the average BMI *z*-score of children in disaster-affected areas was higher than in other areas. For all cohorts, the difference decreased consistently from 2008 to 2010. After the accident, the difference in the BMI *z*-score increased consistently from 2010 to 2014 for the cohort aged 5–7 years. This was in contrast to the other cohorts: for the cohorts aged 8–10 and 11–17 years, the difference in the BMI *z*-score was higher in 2013 than in 2010. The difference in BMI *z*-score declined from 2013 to 2014 for the cohorts aged 8–10 and 11–17. In 2014, that difference amounted to around 0.18, which was lower than preaccident levels. Fig. 2 displays the difference in obesity rates for each cohort. It is evident that the differences in obesity rate after the accident were greater than those preaccident for the cohort aged 5–7 years. However, the difference in obesity rate in 2008 and 2009 for the other cohorts was almost the same as in 2013 and 2014. The obesity rate and BMI thus presented a similar pattern during the study period.

By comparing the disaster-affected and other areas for each cohort, Tables 4a–4c displays the difference in BMI *z*-scores for children before and after the 2011 Fukushima accident. Using the sample for the cohort aged 5–7 years in

[2] The Chernobyl accident was found to reduce happiness levels (Danzer, 2016) and the performance of the labor market in the Ukraine (Lehmann and Wadsworth, 2011). That accident also exerted effects on other European countries. For instance, Germans were found to be more likely to worry about the environment after the Chernobyl disaster (Berger, 2010). In Sweden, students born in regions exposed to higher levels of Chernobyl radiation fallout produced poorer performances at secondary school (Almond et al., 2009). Other major disasters have been shown to influence the outcomes of elections and policies in the United States (Eisensee and Strömberg, 2007; Kahn, 2007).

[3] It should be noted that some areas in Fukushima, Iwate, and Miyagi prefectures were probably unaffected by the disaster. Fukushima Prefecture, for example, consists of three subregions separated by mountain ranges. The nuclear accident occurred only in the coastal area, and other subregions were relatively isolated. Because of data limitations, subregional data on weight, height, and obesity were not available for the present study. Caution is therefore required in interpreting the results of this paper.