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【要旨】

This paper examines long-term consequences of one of the most serious catastrophes ever inflicted on humankind: the atomic bombing that occurred in Hiroshima in 1945. While many victims died immediately or within a few years of the bombing, there were many negative effects on survivors in terms of both health and social/economic aspects that could last many years. Of these two life factors, health and social/economic aspects, the latter has largely been ignored by researchers. We investigate possible long-lasting effects using a new dataset covering the middle and older generations in Hiroshima some 60 years after the tragedy. Our empirical results show that Atomic Bomb Survivors did not necessarily suffer unfavorable life experiences in terms of the average marriage status or educational attainment but did experience significant disadvantages some aspects including the husband/wife combination of married couples, work status, mental health, and expectations for the future. Thus, survivors have suffered for many years after the catastrophe itself.

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Long-term Consequences of the Atomic Bombing in Hiroshima[*]

by

Satoshi Shimizutani and Hiroyuki Yamada[**]

April 2018

Abstract

This paper examines long-term consequences of one of the most serious catastrophes ever inflicted on humankind: the atomic bombing that occurred in Hiroshima in 1945. While many victims died immediately or within a few years of the bombing, there were many negative effects on survivors in terms of both health and social/economic aspects that could last many years. Of these two life factors, health and social/economic aspects, the latter has largely been ignored by researchers. We investigate possible long-lasting effects using a new dataset covering the middle and older generations in Hiroshima some 60 years after the tragedy. Our empirical results show that Atomic Bomb Survivors did not necessarily suffer unfavorable life experiences in terms of the average marriage status or educational attainment but did experience significant disadvantages some aspects including the husband/wife combination of married couples, work status, mental health, and expectations for the future. Thus, survivors have suffered for many years after the catastrophe itself.

Keywords: social discrimination; atomic bomb; radiation exposure; marriage; Hiroshima, Japan.JEL Classification Codes: I18, I31, H12.

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1. Introduction

On the clear, peaceful, and ordinary morning of August 6, 1945, an atomic bomb was delivered from the U.S. military plane *Enola Gay* to the center of the city of Hiroshima in Japan. The bomb exploded at an altitude of 600 meters and released a tremendous and harmful amount of severe radiation, heat rays, overwhelming force and heat of the blasts with a large fireball.

This was the first time in human history for a nuclear weapon to be used for indiscriminate and immediate mass killing and destruction. Indeed, the number of acute deaths from the bomb is estimated to be between 90,000 to 166,000 persons, a significant proportion of Hiroshima city's total population of 340,000-350,000 citizens.[1] This number of acute deaths includes the deaths that were instant as well as those who died within two to four months after the bombing attributable to radiation exposure, i.e. fallout called *black rain*. The number of survivors who declared themselves as having been exposed to radiation, called *hibakusha* in Japanese, both in Hiroshima and Nagasaki was counted to be approximately 280,000 persons in the national census administered in 1950 by the government.

A tremendous and intensive volume of research on the effect of the atomic bombing conducted mainly by scholars and researchers in natural science immediately followed the tragic event. The focus of the research has been mainly the aftereffects of radiation exposure on health, especially the incidence of various cancers and leukemia. Indeed, a specialized research institute, the Atomic Bomb

[1] These figures are taken from the website of Radiation Effects Research Foundation (RERF) "Frequently Asked Questions" (http://www.rerf.or.jp/general/qa_e/qa1.html, accessed on January 15th, 2018) (REFE, N.D.). The corresponding figures for Nagasaki which was hit by the second atomic bombing on August 9, 1945 were 60,000-80,000 for the number of acute deaths and 250,000-270,000 for the number of citizens. The Foundation states that the precise total number of deaths is still not known because of the destruction of military personnel records or deaths of entire family members, etc. The original data sources are found in Hiroshima city and Nagasaki city's Editorial Committee on Journal on the Atomic Bombs' Disaster (1985).

Casualty Commission, (ABCC), was established in Hiroshima in March 1947 (and the one in Nagasaki was established in 1948). In order to examine long-term effects on death and the incidence of cancers caused by the radiation exposure, the ABCC started a longitudinal study in October 1950 on approximately 120,000 persons at the baseline as the *Life Span Study* and related studies. These studies have been ongoing for more than 60 years, even after the ABCC was reorganized as Radiation Effects Research Foundation (RERF) in April 1975.[2] The findings from those surveys are summarized as follows: 1) cancers of specific organs are more frequent among atomic bomb survivors. Second, 2) non-cancer diseases (cataract, benign thyroid tumor, heart disease, stroke), deterioration of the immune system similar to that observed with aging, and minor inflammatory reactions are more likely observed in survivors exposed to high doses of radiation; and 3) neither genetic effect nor an increase in mortality or incidence of cancer have been confirmed to date among survivors' children.[3]

In contrast to the large and intensive volume of medical/epidemiological studies on health of survivors and their children, surprisingly, there has been scarce research on social/economic aspects caused by radiation exposure due to the atomic bombing in social science. There is no reason that negative effects caused by the atomic bombing would be limited to health aspects of survivors. In fact, the atomic bombing could have long-term effects on life events of affected individuals. A noteworthy example is social discrimination against survivors, either explicit or implicit; for example, a survivor could not get married, attain desirable education, or gain a good

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[2] The Life Span Study (LSS) is the main longitudinal survey performed by RERF (RERF, N.D.). Moreover, RERF performs other surveys such as Adult Health Study (AHS), In Utero Study, and Genetic Studies on the Atomic Bomb Survivors' Children.

[3] RERF's website: "Matters elucidated thus far" http://www.rerf.jp/general/research_e/clarify.html, accessed on January 18th, 2018 (RERF, N.D.).

job by the fact or even a simple prejudgment that he/she was exposed to radiation by the atomic bombing. In other words, aftereffects of the atomic bombing could be observed in survivors' life events such as educational attainment, employment, and family formation. Thus, besides potential health/medical issues, such adverse effects could be found in economic/social sources over a lifetime.[4]

This study provides new evidence on long-term effects of the atomic bombing in 1945 on survivors and their children. We collected a variety of information on health, family, employment, and residential status from individuals who were randomly selected in the city of Hiroshima in 2011 with a supplemental survey in 2017. In this study, we aim to contribute to the scarce amount of existing literature in three ways. First, we examine long-term evidence on aftereffects of survivors and their children in a variety of aspects. More than 70 years have passed since the bombing and those who were directly affected are very advanced in age. Thus, now we can examine long-term and nearly comprehensive consequences of the atomic bombing in 1945 on the course of life of individuals. Second, we examine comprehensive outcomes of the radiation exposure, focusing on any negative effects on social/individual aspects quantitatively, which to date have hardly been examined. Most of this line of research thus far, which is described in the next section, relies on a small sample of case-study interviews, but those findings are hard to generalize. Instead, we utilize a new survey on Hiroshima citizens to detect any disadvantages experienced by survivors. Third, we provide quantitative evidence on any gaps between the affected (survivors and their children) and others and thus we fill the gap

[4] A famous Japanese novel, *Kuroi Ame* (*Black Rain*) written by Masuji Ibuse, describes a story in a small village in Hiroshima prefecture but distant from Hiroshima city. In the story, a woman who was not directly exposed to radiation was mistaken as having been affected, rendering her disadvantaged in the marriage market. Finally, women who were affected by the fallout (black rain) developed symptoms of atomic illness and marriage agreements were broken off.

between statistical evidence and knowledge based on in-depth interview of a small sample size of individuals.

This paper proceeds as follows. Section 2 provides a brief description of previous literature on the atomic bombing and related studies. Section 3 explains the dataset used in the empirical analysis. Section 4 performs a descriptive comparison between the affected and the non-affected by the atomic bombing and Section 5 confirms the results by regression analysis and discusses the results. Section 6 specifically examines the combination of married couples. The final section concludes.

2. Previous research

This section reviews previous research on social/individual aspects of the atomic bombing. To our knowledge, there was a series of social science studies on negative effects of the bombing on people's daily lives in the 1960s and 1970s. Those studies were undertaken with a view to criticize the results of *Fact-finding Survey on Atomic Bomb Victims* administered by the Ministry of Health and Welfare in 1965. This government survey (henceforth the 1965 survey) concludes "there is no evidence to support that there is in general a significant difference between atomic bombing survivors and people in the general public in the daily life survey, though there are some significant gaps in some aspects in terms of income, employment situation, employment status, and job separation, etc." (Ministry of Health and Welfare (1967a, b)).[5] The 1965 survey sample consists of people formally designated atomic bomb

[5] Ministry of Health and Welfare was reorganized as Ministry of Health, Labour and Welfare in 2001. The 1965 survey also shows that there is no gap between the victims and the other general people in health outcome; no difference is evident in either blood-related malfunctioning or blood pressure, and there is no evidence to support or reject a particular pattern for the victims such as being susceptible to disease, having less physical strength, or "*bura bura* disease" (chronic fatigue) (Ministry of Health and Welfare, 1967a).

survivors by the government and certified with an atomic bomb notebook (*Hibakusha Kenko Techo*). Note that the conclusion drawn regarding life aspects depends on a comparison of the average of the certified survivors in the sample in the 1965 survey (treatment group) and the average of those who were living outside Hiroshima in a corresponding nationwide survey (control group) administered in the same year.[6]

After the government's report was published, several social scientists rebelled and aimed to provide counter-evidence mainly through in-depth interviews with survivors (see Hama et al. 2013 for a detailed description of the research). A relevant example of the line of those studies is Masami Chubachi's series of works. Chubachi's group performed another survey on 156 atomic bomb survivors in 1966 to examine the slower recovery of regional communities and economic life of households affected more seriously (Chubachi 1968). Other research groups took a non-statistical/sociological approach to reveal any negative aspects of survivors through in-depth interviews (the Ishida group) or made collective efforts to create a detailed residential map around the hypocenter at the time the bomb was dropped through use of survivors' recollections (the Yuzaki group).[7] While those efforts took a serious approach to explore he aftereffects of the bombing, and their findings are compelling and insightful, the results are not supported by statistical evidence and are thus difficult to generalize. Moreover, most of this line of research was concentrated in the 1960s and 1970s and has declined since the 1980s. As a consequence, we have to say that findings on the existence and degree of any social/individual negative

[6] A scholar insists that the 1965 survey clearly intended to provide counter evidence on establishing the "Atomic Bombs' Survivors Relief Act" by intending to show the gap between the affected and the non-affected to be as small as possible, though this statement is not supported by explicit evidence (Hama et. al. 2013, p.42).

[7] Hama et al. (2013) tracks all these research efforts in detail to capture aftereffects of the atomic bombing.

effects on atomic bomb survivors are inconclusive to date. [8]

Turning to research outside Japan, there are some studies that investigated long-term effects of atomic power station accidents on later life. First, Almond et al. (2009) examined the prenatal exposure to the Chernobyl fallout that occurred in April 1986 on the cognitive ability of Swedish students. Using the variation in the fallout by region, the paper shows that the aftereffect of the fallout on cognitive ability is not as serious as that by radiation doses that are currently considered to be harmless, and no effect was detected in health outcomes. Moreover, with regard to performance in secondary school, greater damage is observed in students who were born in higher fallout areas, and the negative effect is large in mathematics for children with less educated parents. Second, Danzer and Danzer (2016), whose spirit is partly shared by this study, investigates the aftereffect of the Chernobyl accident on well-being and mental health 20 years after the accident in Ukraine. Using the geographic variation in the radiation fallout, they found a large and persistent negative effect on life satisfaction, depression, and subjective probability to live to target age.[9]

The current study builds on the previous research and contributes to the literature by providing quantitative evidence that is very long-term (more than 60 years) and comprehensive (health as well as socio-economic outcomes) which we

[8] To our knowledge, there are two studies related to the atomic bombing. Davis and Weinstein (2002) examined the effect of the atomic bombing on the relative position of Hiroshima and Nagasaki in city size. They found that the bombing temporarily destroyed the city size but had no long-term impact on relative size of cities in Japan; the relative size of the cities recovered within 20 years. Yamamura (2013) showed that Hiroshima survivors are more likely to trust others.

[9] If we expand the scope of the literature to that which examined the long-term effect of childhood events, there is a growing number of recent studies. Examples include studies on the fetal origins hypothesis to the effect of fetal shocks and circumstances on education, income, and health in later life (Douglas and Currie (2011)), the effect of childhood health on employment outcomes (Smith (2009)), the effect of childhood nutrition intake on physical and cognitive development (Glewwe and King (2001)), the effect of an adverse event during childhood on child development (Yamano et al. (2005)). In Japan, Shimizutani and Yamada (2014) examined the effect of birth in 1966, a year that is considered disadvantageous for birth of girls under a prevailing superstition, on marriage, employment, and income at around age 40.

intend to differentiate from other studies.

3. Data description

The original dataset used in the empirical analysis is microdata from JSTAR (Japanese Study on Aging and Retirement). JSTAR is a world-standard longitudinal dataset on middle-aged and older generations.[10] Combining interview and self-administered survey, JSTAR covers a wide range of variables related to health, employment, family composition, economic status, and social participation. The unit of the sample of JSTAR is individuals aged 50 to 75 who were randomly chosen from household registration within each municipality at the baseline. JSTAR began to collect data in 2007 in five municipalities (first wave) and added two in 2009 (second wave). Moreover, JSTAR added three more municipalities in 2011-12 (third wave). JSTAR continued to track the individuals in the sample every two years in 2013 (fourth wave) and in 2015 (fifth wave). The total number of the municipalities from the third wave is 10.[11]

Hiroshima city is a municipality in which JSTAR started to collect data during the 2011-12 period. At the baseline, 2,000 individuals aged 50 to 75 were randomly chosen in Hiroshima city based on household registration and, of these, 1,100 individuals cooperated with the survey. The response rate was about 60 percent after removing the individuals who had moved away, were sick, or not at home for an extended period. JSTAR performed the second survey on these Hiroshima residents in

[10] JSTAR is designed to be the Japanese counterpart of Health and Retirement Study (HRS) in the United States, English Longitudinal Study of Ageing (ELSA) in UK, The Survey of Health, Ageing and Retirement in Europe (SHARE) in continental Europe, and other sister surveys.

[11] The five municipalities from the first wave are Takikawa city, Sendai city, Adachi ward (metropolitan Tokyo), Kanazawa city, and Shirakawa town. The two municipalities from the second wave are Naha and Tosu cities. The three municipalities from the third wave are Hiroshima, Chofu, and Tondabayashi cities.

2013, and 870 individuals responded. Similarly, 749 persons cooperated with the third wave in 2015. In addition, a supplemental survey to collect variables essential to this study was performed in 2017 for individuals in Hiroshima and 645 responded.

4. Descriptive analysis

This section performs a descriptive comparison in socio-economic and health outcomes between the two groups. One group is "affected" which is formed based on the following criteria: (a) survivors exposed to radiation by the atomic bombing, or/and (b) those who hold the Atomic Bomb Survivor's Certificate (*Hibakusha Kenko Techo*), and/or (c) the children of the survivors exposed to radiation by the atomic bombing. Whether a respondent in the sample is included in (a) depends on the place where he/she was located on August 6 in 1945, information that is available from the third wave survey in 2015. The respondents who were in Hiroshima city on the day of the bombing are included in this "affected" group. We also include those who hold the Atomic Bomb Survivor's Certificate (*Hibakusha Kenko Techo*) in this group following criteria (b). This information is available from the first wave survey in 2011. A certificate is issued after application by victims who were in Hiroshima or Nagasaki city at the timing of bombing or entered those cities within two weeks after the bombing or persons who were a fetus of those individuals.[12] The criteria (b) group covers respondents who were not in Hiroshima on August 6 in 1945 but were seriously affected by radiation exposure. Note that the individuals under criteria (a) and (b) are not mutually exclusive. In addition, a respondent is included in this group if at least one of his or her parents had declared exposure to radiation by the atomic

[12] The detailed description of eligibility for a certificate is available on the website of Ministry of Health, Labour and Welfare (N.D.). The number of survivors who are certified is about 165,000 as of March 2017.

bombing. The other group is “not affected” and consists of those who currently live in Hiroshima but were not exposed to radiation by the atomic bombing and neither of whose parents were exposed to radiation by the atomic bombing.

Applying the criteria described above to the sample, 653 are defined either as the affected (297 individuals) or as the non-affected (356 individuals). The upper part of Table 1 shows the difference between the affected and the non-affected in terms of marriage and education. We observe some notable results. First, the proportion of males who are currently married (including widows) is 87.0 percent, smaller for the affected than 91.2 percent for the non-affected although the difference is statistically insignificant. The proportion of females who are currently married (including widows) of the affected group is 88.6 percent, slightly smaller than that of the non-affected group (89.8 percent). They are comparable and the gap is not statistically significant.[13] Second, the proportion of males who have never been married in the affected group is 8.1 percent, which is higher than that of the non-affected group, but the gap is not statistically significant at 10 percent. The proportion of females who have never been married of the affected group is 4.0 percent, slightly higher than that of the non-affected group (3.5 percent), and again the gap is not statistically significant. Third, this is also the case for the divorced. The divorce rate is slightly higher for the affected males and females but the gap is not significant between the

[13] The 1965 survey by Ministry of Health and Welfare shows that the marriage proportion is comparable for males but smaller for victims than non-victims for females. The difference comes from several sources. First, the age at the time of the survey is different. The individuals in the JSTAR sample are aged 50 to 75 as of 2011, which corresponds to the generation under age 30 in the 1965 survey. At the timing of the 1965 survey, the marriage rate was not complete due to the timing effect. Second, the treatment group is different. The group in the 1965 survey are those who are officially certified to be entitled to the Atomic Bomb Survivor’s Certificate but the treatment group in this study does not necessarily have the Certificate and includes survivors’ children. Third, the control group is different. The 1965 survey compared the survivors living in Hiroshima and individuals living in other cities, i.e., the average of Japan except Hiroshima. In contrast, we compare the marriage rate between the “official” atomic bombing survivors and those not officially declared atomic bombing survivors, both of whom are currently living in Hiroshima.

affected and the non-affected group. At the end, the proportion of males who have ever been married (including those currently widowed and divorced) is lower among the affected group than the non-affected group, but the gap is not statistically significant. The proportion of females who have ever married is similar between the two groups.

Turning to educational attainment, shown in the lower part of Table 1, we do not see any significant difference between the affected and the non-affected group. For males, the proportion of junior high school graduates is smaller for the affected but the difference is not statistically significant. Although there is some gap in the proportion of graduations of senior high school, two-year college or technical school, and university, none of the differences between the affected and the non-affected group is statistically significant for both males and females.

Next, the upper part of Table 2 reports the employment status at age 54 which captures an aspect of the prime job for each person. We do not compare the current employment status since most of the respondents in our sample have retired. Overall, we do not see significant difference in the proportion of individuals working at age 54, though the proportion is slightly higher for those who were not affected. However, we see some significant gaps if we decompose the working status. The proportion of employees among all workers is higher for the non-affected group than for the affected group. The gap is especially large and statistically significant for females. In other words, if working, the affected females are more likely to be self-employed. This is also the case for males but the gap is not significant. The proportion of managerial workers among all workers is comparable for males but is significantly higher for the affected females. Although we come back to this issue later, a brief answer is because the affected females work in small companies or are self-employed,

they are more likely to be in managerial positions. While there is little gap in the proportion of regular salaried workers among all working adults either male or female, the size of the company seems to matter. The proportion of males who work for large companies whose number of employees exceed 1,000 is lower for the affected group, though the gap is not statistically significant. The gap is also found for females, which, however, is again not statistically significant. The gap in company size is more pronounced for the proportion of those who work for small companies (fewer than 10 employees). The proportion of those who worked for small companies is larger for the affected group, for both males and females and the differences are statistically significant. We also add an observation that the larger proportion of managerial workers for the affected females is consistent with the larger proportion of smaller-size companies such as small-scale family business. Overall, those observations show that the proportion of having a job at age 54 is comparable between the affected and the non-affected group for both sexes but the affected group is more disadvantageous in terms of the proportion of employees (for females) and firm sizes (both males and females).

The lower part of Table 2 shows the difference in terms of residential status. The sample in this part combines males and females. The proportion of those who own their houses (do not rent) is slightly higher for the affected group, though the gap is not significant. In contrast, the proportion of those who inherited the house they own is much higher for the affected group and the difference is statistically significant. Moreover, the house size is larger for the affected group among house-owners and the gap is statistically significant. These observations indicate that the affected group is more likely to inherit a house than the non-affected group and that the physical size of the house is larger. In other words, the affected group seems to be

more advantaged in inheritance and house size, but the inference might be that their parents took care of them to compensate for possible future disadvantages.[14]

Table 3 reports the difference in health outcomes, expectations, and cognitive skills between the affected and the non-affected group. First, we do not see a significant difference in subjective measures among males by the information on the self-rated health status or subjective life satisfaction. The proportion of those whose health is reported to be very good or good is lower for the affected group but the gap is not significant for either males or females. Subjective life satisfaction is closely comparable between the affected and non-affected group for both male and female.

Second, a subjective probability of survival up to age 80 or 85 is significantly different between the affected and non-affected groups for men. The average probability to live to 80 or 85 years old in the affected group is significantly lower than that in the non-affected group. This could imply that males in the affected group are significantly likely to be more pessimistic about their future life than males in the non-affected group. At the same time, this might lead to the higher incidence of depressive state measured by the Center for Epidemiological Studies-Depression (CES-D) scale among the affected group, and the gap is statistically significant.[15] In contrast to the significant gap observed for males, there is no significant difference for females in subjective probability of survival nor is there for incidence of depressive state in the CES-D scale between the affected and the non-affected group.

Third, there is not any significant difference in cognitive ability (word recall and serial seven clinical tests) between the affected and the non-affected groups

[14] Almond et al. (2009) discusses that no detected difference in health outcomes across region with different levels of fallout may come from the situation that parental investments compensated for the initial damage.

[15] The threshold to detect a depressive state is set to be whether the sum of scores exceed 20 or not following a recent meta-analysis study (Vilagut et al. 2016). The gap is significant at five percent level if we compare the simple average of the sum of scores.

except for females' late word recall. In JSTAR, the interviewees are asked to recall 10 words immediately after they are announced and again after an interval toward the end of the cognitive ability section of the interview, which is called "late recall." In the serial seven, interviewees are asked to subtract seven from 100 sequentially five times, resulting in the correct answer of 65.

In sum, we see some gaps in life event outcomes between the affected group that experience radiation exposure due to the atomic bombing and the non-affected group. First, overall, we do not see a statistical difference in marriage status or educational attainment between the affected and the non-affected group. Second, we see a clearer difference in employment status: the affected group is more likely to be disadvantaged in terms of the proportion of employees (for females) and company size (both males and females). In contrast, the affected group is more advantaged in housing status in that they are more likely to inherit family houses whose size is larger. Third, we do not see any differences in health or cognitive skills but do see significant difference among males in terms of their subjective probability to live longer lives and incidence of depressive state, showing that the affected males are more likely to be pessimistic. Overall, we do not see any advantages for the affected other than the housing status but do significant disadvantages in some aspects especially in job environment, mental health, and length of life expectations.

5. Regression analysis

So far, we have shown a descriptive comparison of a variety of outcomes between the affected and non-affected groups in marriage, education, housing, employment, health, and expectations. However, a simple comparison in averages does not control for confounding factors. In this section, we try to control some

important variables using regression analysis to distill the gap between the affected and the non-affected groups more precisely. We use a simple linear model as following:

$$y_i = \beta_1 Affected_i + x_i'\beta_2 + \varepsilon_i$$

where y_i is various outcome variables and $Affected_i$ is a dummy taking 1 if an individual *i* is in the affected group, otherwise zero. x_i is a vector of other control variables (including a constant term) of *i* , and ε_i is an error term. β_1 and β_2 are the parameters to be estimated and our main interest is the sign and statistical significance of β_1.We use this model for marriage status, employment at age 54 and health outcomes for males and females separately. The set of control variables slightly differs depending on dependent variables, which is explained below. In the estimation, robust standard errors are used.

Table 4 reports the estimation results. First, we examine a variety of marriage status outcomes. The control variables are age and education dummies.[16] We find no significant coefficient on the dummy variable for the affected group in the "currently married" regression. We also do not find any statistical significance in the proportion of the unmarried, divorced, or ever married. Overall, we do not see any significant difference in marital status between the affected and the non-affected group.

Second, we examine any gap at the employment status at age 54. The control variables are age and education dummies.[17] We do not see any statistical difference in

[16] Unfortunately, JSTAR contains little information regarding the characteristics of individuals at the timing of marriage. Thus, we include only the variables just mentioned.
[17] JSTAR has scarce information at the time of age 54 except the cohort that is 54 years old when the survey was conducted. Thus, we include only the variables that are mentioned in the text.

terms of proportion of working for males or females. However, we see some differences in employment status. We have found a significant difference in the proportion of employees among all workers for females in the mean comparison and the observation holds even after controlling for the covariates. The gap is large at 22.1 percent, meaning that the affected females are less likely to be employed (i.e. more likely to be self-employed) by more than 20 percent among workers. While the coefficients is also negative for men, the gap is smaller and not significant. We see positive coefficients on the dummy variable for the affected group in the proportion of management jobs and the coefficient is significant for females, which again conforms to the observation in the descriptive mean comparison above. We see negative coefficients on the dummy for the affected group in the proportion of regular workers, either male or female, but they are small and insignificant. Finally, we observe significant and large differences in terms of company size. The coefficients are negative for both sexes and significant for males if the dependent variable takes one for large companies with more than 1,000 employees and zero otherwise. The mean comparison also shows smaller figures for the affected group but the gap is not significant. Now, we find that males in the affected group are less likely to be employed at large companies and the gap is significant. Moreover, the coefficients are positive and significant for both sexes if the dependent variable takes one for small companies with less than 10 employees, which conforms to the pattern in the mean comparison. The gap is large at 14.6 percent for males and 18.5 percent for females, showing that the affected persons are disadvantaged in that they are more likely to work for smaller companies. Overall, we find significant disadvantages in the proportion to be employed (females), the proportion of management job (females) and company size (both males and females) for the affected group, showing that job status

is clearly in favor of the non-affected group in those aspects.

Third, we investigate the difference in health status, survival probability (expectation), depressive state (mental health), and cognitive skills. When the outcome variable is self-rated (or subjective) health status, we control current marriage status (currently married or not) in addition to age and education dummies. For all other outcomes, we control the index of self-rated (subjective) health status in addition to current marriage status, age, and education dummies. We see negative coefficients on the dummy for the affected group in the overall health status regression and the coefficient is significant for males. This means that self-rated health status is significantly lower for the affected groups if the covariates are controlled. The coefficients are small and not significant when the dependent variable is overall life satisfaction. Turning to the survival probability, the coefficients are negative for males and significant when the dependent variable is to live to age 85, meaning that males in the affected group are significantly more pessimistic regarding their longevity. These coefficients are positive but not significant for females. Moreover, the coefficients are positive for both sexes and significant for males in the depression regression, showing that males in the affected group are more likely to be depressed than those in the non-affected group. These results show that the affected males are disadvantaged in overall health status, survival probability to live up to age 85, and incidence of depression.

Fourth, turning to cognitive skills, we see no significant coefficients except the one for the females' late word recall. The coefficients are negative in the word recall regressions (either immediate or late) but only females' late word recall is statistically significant. The coefficients are positive but not significant when the dependent variable is accurate responses to the serial seven. Thus, we do not see any significant

distinction between the affected and the non-affected group in cognitive ability.

In sum, we found some significant gaps between the affected and the non-affected groups even after controlling for the covariates. The affected group is less likely to be employed (females) or more likely to be in management positions (females) and is more likely to be disadvantaged in company size. Moreover, males in the affected group are unfavorable in overall health status, subjective probability, and depressive state. These observations show that disadvantage for survivors is found significantly not in marriage or education but in some aspects of work status, mental health, and expectations. These findings clearly show that affected people have suffered from the catastrophe after many years and this is the evidence that this study provides for the first time. We emphasize that these statistical gaps are clearly found in our relatively small sample size. At the same time, we also make note of reservations regarding the regression analysis. We implicitly assume that the affected group dummy ($Affected_i$) and the error term (ε_i) are orthogonal. While this assumption is crucial for the identification strategy, whether it truly holds or not could be a matter of discussion. A standard solution in the case where this assumption does not hold is to use an instrumental variable. Unfortunately, it is hard to find a convincing instrument variable for $Affected_i$ in the data at hand.

6. Combination of married couples

Lastly, we address the possibility of any disadvantages in the marriage market. We confirmed that the gap in the proportion of those who are currently married or widowed is not detected. In addition, we do not see any significant difference in the proportion of those who are unmarried or divorced. While we do not see any difference in terms of the proportions of marriage outcomes, however, an individual

in the affected group may be more likely to be marry a member of the affected group than someone in the non-affected group. In other words, the combination in couples may differ between the affected and the non-affected groups and this possibility cannot be detected in the analytical approach taken above.

Table 5 shows the results. We restrict the sample to those men and women whose years of starting to live in Hiroshima city is earlier than the years that they got married. By restricting to these terms, we use the sample of males and females who are implicitly assumed to be in the marriage market in Hiroshima city. We observe that an individual in the affected group is more likely to be married to a person also in the affected group and the tendency is significantly different from the non-affected group. If a male was affected by radiation exposure due to the atomic bombing, his wife is more likely to be affected; the proportion of wives who were affected for husbands in the affected group is up to 61 percent, which is much higher than the proportion of wives who were not affected (45 percent). This is also the case for females; a female in the affected group is more likely to be married to a male in the affected group, and the pattern is significantly different from that for the non-affected group. The proportion of husbands who were affected is up to 55 percent for wives in the affected group, which is much higher than the proportion for wives who were not affected (39 percent). While the simple averages in the marital status cannot reveal a difference in combination of husbands and wives, now we detect suggestive evidence on social discrimination against atomic bomb survivors; one in the affected group is not in a significantly unfavorable position in the marriage market in terms of proportions but an individual in the affected group is more likely to marry another individual also in the affected group.

The middle and lower parts of Table 5 reports the results when we decompose

the affected group to those belonging to the first or second generation, respectively. The first generation group consists of (a) survivors exposed to radiation by the atomic bombing, or/and (b) those who hold an Atomic Bomb Survivor's Certificate, which was defined in Section 3. The second generation group contains children of the survivors exposed to radiation by the atomic bombing. The middle part shows that a male in the affected group is more likely to marry a female also in the affected group, which is the same as observed in the top panel, though the gap in the average is not statistically significant. The gap is large but not significant probably due to the small sample. On the other hand, a female in the affected group is not necessarily more likely to marry a male also in the affected group and the average proportion is comparable. Again, we should note that the sample size in this comparison is very small.

In contrast, the gap is pronounced in the bottom part for the second generation. An affected male is more likely to marry a female also in the affected group and the gap is large (about 15 percent) and statistically significant. This is also the case for the reverse: an affected female is more likely to marry a male also in the affected group and the gap is large (again about 15 percent) and statistically significant. We should note that the sample size is larger than those in the first generation but still small. Thus, we see that the gap is large and clearly observed even in the small size of the sample. What is serious is that the combination of an affected husband and an affected wife is more evident in the second generation than in the first generation. This observation shows that social discrimination with regard to the atomic bombing in Hiroshima lasts for at least until the succeeding generation.

7. Conclusion

This paper provides the first comprehensive evidence on long-term outcomes of the atomic bombing in Hiroshima that occurred on August 6, 1945. We utilize a new dataset on the middle and older generations in Hiroshima city and focus on possible negative aftereffects on health as well as economic/social status of survivors and their children, which to date has not been quantitatively investigated. We show that, more than 60 years after the tragic event, survivors and their children are not seriously disadvantaged in marriage status or educational attainment but some significant distinctions between the affected and the non-affected group is observed in such aspects as combination of married couples, work status, mental health, and expectations.

This study shows that survivors and their children have indeed suffered from the catastrophe for many years after the occurrence. We believe that our finding contributes to understanding of social disadvantages against victims in catastrophes, an important subject that is gaining attention. Even if we limit our scope to radiation exposure, the accident of the Fukushima atomic power station in March 2011 is closely relevant to this study. While there are no victims who died in the accident, it is well-known that many residents around the power station were forced to leave their own region. Many refugees still live in shelters located far away from their homes and social ties have been broken. After the long duration of living in shelters, some families moved to cities, and there are indeed occasions when refugees have experienced discrimination solely because they come from the Fukushima area, whether or not they were exposed to radiation from the accident. The experience of Hiroshima examined in this study indicates a possibility that people from Fukushima will suffer from disadvantages in life events in later years. Further research should address how to mitigate such prejudice and social discrimination against victims.

References

Almond, Douglas, Lena Edlund and Mårten Palme (2009). "Chernobyl's Subclinical Legacy: Prenatal Exposure to Radioactive Fallout and School Outcomes in Sweden," *Quarterly Journal of Economics*, vol.124, Issue 4, pp. 1729–1772.

Chubachi, Masami (1968). "The Structural Features of Daily Lives of the Victims: Focusing on Interview Survey in the Hiroshima area [Hibakusha Seikatsu no Kouzou teki Tokushitsu: Hiroshima Chiiki ni okeru Mensetsu Chosa wo Chushin to shite] (in Japanese)," *Mita Gakkai Zasshi [Mita Journal of Economics]*, vol.61, No.12, pp.1-28.

Danzer, Alexander and Natalia Danzer (2016). "The long-run consequences of Chernobyl: Evidence on subjective well-being, mental health and welfare," *Journal of Public Economics* vol.135, pp.47-60.

Davis, Donald and David Weinstein (2002). "Bones, Bombs, and Break Points: The Geography of Economic Activity," *American Economic Review* vol.92, no.5, pp.1269-1289.

Douglas, Almond and Janet Currie (2011). "Killing Me Softly: The Fetal Origins Hypothesis." *Journal of Economic Perspectives*, vol.25, no.3, pp.153-172.

Glewwe, Paul and Elizabeth King (2001). "The Impact of Early Childhood Nutritional Status on Cognitive Development: Does the Timing of Malnutrition Matter?" *World Bank Economic Review*, vol.15, no.1, pp.81-113.

Hama, Hideo, Ken Arisue and Hideki Takemura eds (2013). Reading the Hibakusha Surveys: Inheriting Hiroshima/Nagasaki *[Hibakusha Chosa o Yomu: Hiroshima Nagasaki no Keisho] (in Japanese)* Keio University Press, Tokyo.

Hiroshima city and Nagasaki city's Editorial Committee on Journal on the Atomic Bombs' Disaster [Hiroshima-shi Nagasaki-shi Genbaku Saigai shi Henshu Iinkai] (1985). *The Atomic Bombs' Disaster in Hiroshima and Nagasaki [Genbaku Higai Hiroshima Nagasaki]* (in Japanese) Iwanami Shoten Publisher, Tokyo.

Ibuse, Masuji (1966) *Kuroi Ame (Black Rain)* Shinchosha Publishing, Tokyo (English translation by John Bester titled "Black Rain" Kodansha International Publishing in 1978).

Ministry of Health and Welfare (1967a). *Fact-finding Survey on Atomic Bomb Victims: Summary of the Basic Survey [Genshi Bakudan Higaisha Zittai Chousa: Kihon Chousa no Gaiyou]* (in Japanese).

Ministry of Health and Welfare (1967b). *Fact-finding Survey on Atomic Bomb Victims: Summary of the Health and Daily Life Survey [Genshi Bakudan Higaisha Zittai Chousa: Kenkou oyobi Seikatsu Chousa no Gaiyo]* (in Japanese).

Ministry of Health, Labour and Welfare (N.D.) *Applications from Overseas for the Issuance of Atomic Bomb Survivor's Certificates* http://www.mhlw.go.jp/bunya/kenkou/pdf/english.pdf

Radiation Effects Research Foundation (RERF) (N.D.). Website http://www.rerf.jp/index_e.html

Shimizutani, Satoshi and Hiroyuki Yamada (2014). "Long-term Consequences of Birth in an "Unlucky" Year: Evidence from Japanese Women Born in 1966," *Applied Economics Letters*, vol.21, issue 16, 2014, pp. 1174-1178

Smith, James (2009). "The Impact of childhood Health on Adult Labor Market Outcomes" *Review of Economics and Statistics*, vol.91, no.3, pp.478-489.

Vilagut, Gemma, Carlos G. Forero, Gabriela Barbaglia and Jordi Alonso (2016).

"Screening for depression in the general population with the center for epidemiologic studies depression (CES-D): a systematic review with meta-analysis." *PloS one*, vol.11, no. 5: e0155431.

Yamamura, Eiji (2013). "Atomic bombs and the long-run effect on trust: Experiences in Hiroshima and Nagasaki," *Journal of Behavioral and Experimental Economics* vol. 46, issue C, pp.17-24.

Yamano, Takashi, Harold Alderman and Luc Christiaensen (2005). "Child Growth, Shocks, and Food Aid in Rural Ethiopia," *American Journal of Agricultural Economics*, vol.87, no. 2, pp.273−288.

Table 1: Marital status and educational attainment				
	Male respondents		**Female respondents**	
	Affected	Non-affected	Affected	Non-affected
	(1)	(2)	(3)	(4)
Marriage status				
Currently married (=1, otherwise 0, widow counted as =1)	0.870	0.912	0.886	0.898
Standard Error	0.027	0.022	0.025	0.021
# of Observations	147	159	150	197
T-test of equality (Pr(|T| > |t|))		0.247		0.724
Widowed (=1, otherwise 0)	0.047	0.031	0.113	0.152
Standard Error	0.017	0.013	0.025	0.025
# of Observations	147	159	150	197
T-test of equality (Pr(|T| > |t|))		0.468		0.294
Unmarried (=1, otherwise 0)	0.081	0.050	0.040	0.035
Standard Error	0.022	0.017	0.016	0.013
# of Observations	147	159	150	197
T-test of equality (Pr(|T| > |t|))		0.269		0.828
Divorce (=1, otherwise 0)	0.047	0.037	0.073	0.065
Standard Error	0.017	0.015	0.021	0.017
# of Observations	147	159	150	197
T-test of equality (Pr(|T| > |t|))		0.669		0.790
Ever married				
(=1, otherwise 0, widow and divorce counted as =1)	0.918	0.949	0.960	0.964
Standard Error	0.022	0.017	0.016	0.013
# of Observations	147	159	150	197
T-test of equality (Pr(|T| > |t|))		0.269		0.828
Education				
Junior high school (=1, otherwise 0)	0.129	0.163	0.113	0.127
Standard Error	0.027	0.029	0.025	0.023
# of Observations	147	159	150	196
T-test of equality (Pr(|T| > |t|))		0.399		0.689
Senior high school (=1, otherwise 0)	0.442	0.427	0.506	0.535
Standard Error	0.041	0.039	0.040	0.035
# of Observations	147	159	150	196
T-test of equality (Pr(|T| > |t|))		0.799		0.593
Two-year college or technical school (=1, otherwise 0)	0.061	0.100	0.320	0.270
Standard Error	0.019	0.023	0.038	0.031
# of Observations	147	159	150	196
T-test of equality (Pr(|T| > |t|))		0.209		0.316
University graduates (=1, otherwise 0)	0.340	0.308	0.053	0.061
Standard Error	0.039	0.036	0.018	0.017
# of Observations	147	159	150	196
T-test of equality (Pr(|T| > |t|))		0.301		0.756
Notes:				
p-Value (numbers in the rows 'T-test of equality (Pr(|T| > |t|))') is on two-sample test for equal mean				
between (1) and (2) or (3) and (4). ***, ** or * refers to the significant level at 1%, 5% or 10%, respectively.				

Table 2: Work at age 54 and housing status				
	Male respondents		**Female respondents**	
	Affected	Non-affected	Affected	Non-affected
	(1)	(2)	(4)	(5)
Work at age 54				
Work at 54? (=1, otherwise 0)	0.967	0.992	0.719	0.760
Standard Error	0.015	0.007	0.041	0.032
# of Observations	124	130	121	171
T-test of equality (Pr(|T| > |t|))		0.160		0.428
Employees among all workers	0.750	0.804	0.609	0.795
Standard Error	0.039	0.035	0.054	0.035
# of Observations	120	128	82	127
T-test of equality (Pr(|T| > |t|))		0.302		0.003***
Managerial worker among all workers	0.125	0.101	0.085	0.031
Standard Error	0.030	0.026	0.031	0.015
# of Observations	120	128	82	127
T-test of equality (Pr(|T| > |t|))		0.561		0.079*
Regular workers among all workers	0.844	0.838	0.349	0.382
Standard Error	0.033	0.033	0.052	0.043
# of Observations	116	124	83	128
T-test of equality (Pr(|T| > |t|))		0.897		0.625
Firm size ≥1000 employees	0.176	0.248	0.060	0.125
Standard Error	0.035	0.038	0.026	0.029
# of Observations	119	125	82	125
T-test of equality (Pr(|T| > |t|))		0.174		0.161
Firm size <=10 employees	0.302	0.192	0.414	0.240
Standard Error	0.042	0.035	0.054	0.038
# of Observations	119	125	82	125
T-test of equality (Pr(|T| > |t|))		0.045**		0.007***
Housing	**Full sample**			
Own a house? (=1, otherwise 0)	0.830	0.786		
Standard Error	0.022	0.021		
# of Observations	284	351		
T-test of equality (Pr(|T| > |t|))		0.157		
Inherited house or not? (=1, otherwise 0)	0.416	0.245		
Standard Error	0.036	0.028		
# of Observations	185	228		
T-test of equality (Pr(|T| > |t|))		0.000***		
House size in m^2 (given owning a house)	216.633	177.483		
Standard Error	12.752	7.275		
# of Observations	199	248		
T-test of equality (Pr(|T| > |t|))		0.005***		
Notes:				
p-Value (numbers in the rows 'T-test of equality (Pr(|T| > |t|))') is on two-sample test for equal mean between (1) and (2) or (3) and (4). ***, ** or * refers to the significant level at 1%, 5% or 10%, respectively.				

Table 3: Current health status, expectations and cognitive ability				
	Male respondents		Female respondents	
	Affected	Non-affected	Affected	Non-affected
	(1)	(2)	(3)	(4)
Health status/life satisfaction				
Self-rated current health status				
(=1 if very good, good, or somehow good, 0 otherwise)	0.826	0.873	0.846	0.877
Standard Error	0.031	0.026	0.029	0.023
# of Observations	144	158	150	196
T-test of equality (Pr(|T| > |t|))		0.253		0.407
Subjective satisfaction				
(=1 if satisfied or somehow satisfied, 0 otherwise)	0.820	0.823	0.794	0.795
Standard Error	0.032	0.030	0.033	0.029
# of Observations	139	153	146	191
T-test of equality (Pr(|T| > |t|))		0.940		0.976
Subjective survival probability				
Subjective probability of survival up to 80 years old	51.350	60.371	67.707	67.353
Standard Error	2.893	2.948	2.704	2.280
# of Observations	137	156	147	195
T-test of equality (Pr(|T| > |t|))		0.030**		0.920
Subjective probability of survival up to 85 years old	25.299	34.679	42.687	41.425
Standard Error	2.524	2.755	2.910	2.500
# of Observations	137	156	147	195
T-test of equality (Pr(|T| > |t|))		0.013**		0.742
Depression				
CESD (=1 if the score>=20, 0 otherwise)	0.097	0.036	0.112	0.124
Standard Error	0.025	0.016	0.028	0.025
# of Observations	134	136	125	169
T-test of equality (Pr(|T| > |t|))		0.047**		0.749
Cognitive ability				
Word recall: immediate (range 0-10)	4.414	4.471	5.293	5.416
Standard Error	0.180	0.184	0.160	0.136
# of Observations	147	159	150	197
T-test of equality (Pr(|T| > |t|))		0.826		0.558
Word recall: late (range 0-10)	3.938	3.968	4.586	5.015
Standard Error	0.190	0.187	0.178	0.151
# of Observations	147	159	150	197
T-test of equality (Pr(|T| > |t|))		0.911		0.067*
Serial 7 (subtract 7 for 5 times from 100)				
(=1 if the answer is correct, 0 otherwise)	0.625	0.622	0.606	0.609
Standard Error	0.040	0.038	0.040	0.034
# of Observations	147	159	150	197
T-test of equality (Pr(|T| > |t|))		0.954		0.962
Notes:				
p-Value (numbers in the rows 'T-test of equality (Pr(|T| > |t|))') is on two-sample test for equal mean between (1) and (2) or (3) and (4). ***, ** or * refers to the significant level at 1%, 5% or 10%, respectively.				

Table 4: Estimated gaps between the affected and the non-affected group

(1) Marriage Status

Dependent variables	Currently married		Unmarried		Divorced		Ever married	
	Male	Female	Male	Female	Male	Female	Male	Female
The affected group	-0.023	-0.012	0.019	0.005	0.004	0.007	-0.019	-0.005
(dummy)	[0.037]	[0.034]	[0.030]	[0.020]	[0.025]	[0.028]	[0.030]	[0.020]
Observations	306	346	306	346	306	346	306	346
R-squared	0.058	0.032	0.038	0.031	0.020	0.017	0.038	0.031

(2) Work at age 54

Dependent variables	Work or not		Employees		Management job		Regular workers		Large firms		Small firms	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
The affected group	-0.021	-0.052	-0.085	-0.221***	0.045	0.063*	-0.007	-0.013	-0.107*	-0.059	0.146***	0.185***
(dummy)	[0.016]	[0.053]	[0.054]	[0.062]	[0.039]	[0.036]	[0.051]	[0.068]	[0.057]	[0.039]	[0.056]	[0.068]
Observations	254	291	248	209	248	209	240	211	244	207	244	207
R-squared	0.041	0.018	0.027	0.144	0.041	0.036	0.036	0.040	0.045	0.018	0.077	0.068

(3) Health status, survival probability and depression

Dependent variables	Overall health status		Overall satisfaction		Survival probability (age80)		Survival probability (age85)		Depression (CESD)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
The affected group	-0.071*	-0.036	0.003	0.004	-6.655	0.867	-8.671**	1.792	0.063**	-0.028
(dummy)	[0.042]	[0.038]	[0.046]	[0.044]	[4.247]	[3.413]	[3.920]	[3.749]	[0.030]	[0.037]
Observations	302	345	288	335	290	341	290	341	266	292
R-squared	0.050	0.030	0.087	0.083	0.067	0.097	0.035	0.069	0.032	0.091

(4) Cognitive skills

Dependent variables	Word recall (immediate)		Word recall (late)		Serial 7	
	Male	Female	Male	Female	Male	Female
The affected group	-0.083	-0.151	-0.073	-0.491**	-0.017	-0.005
(dummy)	[0.273]	[0.209]	[0.283]	[0.229]	[0.058]	[0.052]
Observations	302	345	302	345	302	345
R-squared	0.027	0.067	0.026	0.093	0.040	0.089

Notes: Robust standard errors in brackets. Control variables depends on dependent one, which are refered to in the text.

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Combination of married couples					
	Husband			Wife	
	Affected	Non-affected		Affected	Non-affected
Married with an affected spouse (=1, otherwise 0)	0.605	0.448		0.552	0.394
	0.045	0.044		0.044	0.045
# of Observations	114	125		125	114
Pr(|T| > |t|)		0.014**			0.014**
First generation	Husband			Wife	
	Affected	Non-affected		Affected	Non-affected
Married with an affected spouse (=1, otherwise 0)	0.555	0.426		0.275	0.243
Standard Error	0.083	0.063		0.084	0.067
# of Observations	36	61		29	41
Pr(|T| > |t|)		0.222			0.767
Second generation	Husband			Wife	
	Affected	Non-affected		Affected	Non-affected
Married with an affected spouse (=1, otherwise 0)	0.628	0.468		0.635	0.479
Standard Error	0.055	0.062		0.049	0.058
# of Observations	78	64		96	73
Pr(|T| > |t|)		0.057*			0.042**
Notes:					
*** p<0.01, ** p<0.05, * p<0.1					