



# The effects of birth weight: Does fetal origin really matter for long-run outcomes?<sup>☆,☆☆</sup>



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## HIGHLIGHTS

- We examine the causal effect of birth weight on outcomes later in life.
- We employ the twin-fixed effect model using a large size of twins sample in Japan.
- Birth weight has a significant effect on academic achievement around the age of 15.
- However, the effect is not long-lasting: no effect on the highest years of schooling and earnings.

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## ABSTRACT

This paper investigates whether birth weight itself causes individuals' future life chances. By using a sample of twins in Japan and controlling for the potential effects of genes and family backgrounds, we examine the effect of birth weight on later educational and economic outcomes. The most important finding is that birth weight has a causal effect on academic achievement around the age of 15, but not on the highest years of schooling and earnings.

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## 1. Introduction

It would be generally better to have a small baby at birth and then raise him/her to grow big later in life—this has long been believed to be good practice in child-bearing in Japan. Before C-section delivery or other obstetric procedures became popular throughout society, people perhaps aimed to reduce the risk of endangering mothers' lives by giving birth to a small baby. This widespread belief seems to be still dominant today. However, it is unexpectedly little known that there is a hidden risk of having a small baby: recent research has found that low birth weight is significantly associated with both short- and long-run adult outcomes (Almond and Currie, 2011; Conley and Bennett, 2000; Linnet et al., 2006; Currie and Hyson, 1999).<sup>3</sup>

<sup>3</sup> In particular, Almond and Currie (2011) conducted the detailed and comprehensive survey on the effect of the investments in early childhood education to the later life outcomes.

Low birth weight is caused by preterm delivery or low fetal growth that may reflect a variation in nutritional intake in the womb. Low-birth weight is thus recognized as the leading indicator of poor health among infants, which may delay brain and somatic development and then affect a wide range of subsequent outcomes later in life. Like evidence drawn from data in other countries, in Japan, Kohara and Ohtake (2009) found a negative correlation between birth weight and academic achievements measured by standardized test scores in G6 and G9 at the prefecture level. If this is the case, can there be any doubt that the Government of Japan must shape a policy agenda to increase the birth weight of new born babies, for example, through improvements in the health of pregnant mothers? Unfortunately, however, there is no simple answer to this question.

While much is known about the cross-sectional correlation between birth weight and adulthood outcomes, little is known regarding the extent to what would have happened to an individual outcome if a person who was actually born with a heavier birth weight had been born with a lighter birth weight. In other words, it is highly possible that observed differences in birth weights among new-born infants may simply reflect unobserved parental characteristics which are also correlated with adulthood outcomes of an individual: a selection bias arises when part of individual outcomes can be explained by unobserved parental characteristics. Observed correlations using cross-sectional data in previous literature thus did not provide a full description of the effect of birth weight and result in biased and inconsistent estimates.

In this research, we would like to answer the questions of whether birth weight itself *causes* individuals' adulthood outcomes. One of the innovative methods that social scientists have employed in recent years to address the causal relationship between birth weight and adulthood outcomes is to use a sample of twins. In fact, many economists (see Currie (2009) for a comprehensive survey) use a dataset containing information on twin-pairs and attempt to cope with the problem of unobserved differences in ability and family environments. These considerable efforts have been dedicated to uncovering the effect of birth weight on adulthood outcomes: previous research reached a consensus that birth weight does matter both in the short- and long-run.

We also follow this approach to deal with the bias described above, comparing the differences between twin-pairs to isolate the pure effect of birth weight on the adulthood outcomes, holding innate abilities and family environments constant. Another advantage of using a sample of twins is that, because twin pairs have the same gestation length, the differences in birth weight between twins are attributed solely to differences in fetal growth rates. The main research question of interest in this paper is thus: does nutrition intake in utero really matter for one's life chance? If so, which stage of one's life is the most affected?

To the best of our knowledge, the case of Japan is relatively unexplored due to the data limitation. This is unfortunate given the recent variable findings in Japan that low birth weight is associated with parental socioeconomic factors, such as the mother's smoking habits and employment status (e.g., Kawaguchi and Noguchi (2012b)). The understanding of whether an individual inherits his/her parental socioeconomic status at fetal origin would contribute to further discussion of the intergenerational transmission mechanism of social stratification, to which policy circles may pay considerable attention. In this study, we take advantage of the unique twins-datasets that the authors have collected in Japan through a web-based survey.

To answer our research questions, we follow the protocol of previous literature and outline a twin-fixed effect strategy using a sample of monozygotic twins (hereafter, MZ twins) who are genetically identical. Interestingly, there is a variation in birth

weight between twin-pairs in general. As pointed out by Ashenfelter and Rouse (1998), first-born twins are usually heavier than their second-born siblings at birth. This setting allows us to create a counterfactual situation of what would have happened to adulthood outcomes of a pair of twin who were born with a lower birth weight if s/he had been born with a heavier birth weight instead. We then set up five main outcomes to be examined: (i) participation in private (or national) middle schools; (ii) student performance at the age of around 15; (iii) ranking at the college attended; (iv) years of schooling; and (v) earnings. The significant finding in this paper is that birth weight only causes academic achievement around the age of 15. Unlike evidence from western countries, this effect subsequently disappears. Our empirical results show that fetal growth may affect student performance in young children, but it does not directly affect his/her adulthood outcomes in later life, such as educational attainments and earnings.

## 2. Relevant literature

A growing body of research has attempted to identify the causal effects of birth weight on not only short-term but also long-term outcomes by the use of twin data. In this section, we review the relevant literature investigating the causal effect of birth weight on educational and economic outcomes, in particular by using twin data. Regarding educational outcomes, there is evidence based on twin studies that birth weight has a long-term impact. Behrman and Rosenzweig (2004), Black et al. (2007) and Oreopoulos et al. (2008), using twin data from Minnesota, Norway and Manitoba, respectively, found that birth weight has a positive effect on high school completion. Lin and Liu (2009) analyzed Taiwanese twin data and found that birth weight increased grades at age 15. It is noteworthy that Behrman and Rosenzweig (2004) and Lin and Liu (2009) showed that the OLS coefficients for birth weight without controlling for genes and family backgrounds are underestimated by 50%, while Black et al. (2007) found that OLS estimates and twin-fixed effects are similar in size. Behrman and Rosenzweig (2004) and Lin and Liu (2009) argue that their findings suggest that parents may invest more in lighter twins to make up for their developmental disadvantage.

However, some studies suggest that the effect of birth weight on years of schooling is rather small (Royer, 2009) or that there is no significant relationship between birth weight and educational attainment or cognitive ability measured by language test scores (Miller et al., 2005; Oreopoulos et al., 2008). It remains unclear whether this mixed evidence is due to differences in measures regarding educational outcomes or data sources.

There is relatively less evidence on the direct effect of birth weight on economic outcomes. Miller et al. (2005) are one of the exceptional groups of researchers who found a positive, direct effect of birth weight on earnings, but argue that birth weight plays only a minor role in determining earnings, with each additional ounce of birth weight increasing earnings by 0.4%. Other studies that examine the effect of birth weight on economic outcomes include Royer (2009) and Oreopoulos et al. (2008). However, Royer (2009) did not find evidence to show that birth weight is associated with neighborhood income levels in adulthood. Although Oreopoulos et al. (2008) found that birth weight affects social assistance take up and length in adulthood, but given that they also found the effect of birth weight on high school completion, it is unclear whether the birth weight effect on economic outcomes would remain after controlling for the mediating effect of educational outcomes.

In Japan, no research has used twin data to investigate the causal effect of birth weight on educational and economic outcomes in adulthood. The most important reference work is a non-twin study conducted by Kawaguchi and Noguchi (2012b)

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