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Disease and child growth in industrialising Japan: Critical windows and the growth pattern, 1917–39[☆]

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ABSTRACT

This paper assesses how the disease environment, proxied by infant mortality rates, influenced children's growth in interwar Japan. We use data drawn from government records from 1929 to 1939 which report the mean heights of boys and girls in school at each age (6–18) for each of Japan's 47 prefectures. We focus on two key questions: (1) how important was the disease environment in infancy in shaping the growth pattern of children? and (2) were shocks to child health more salient in the first thousand days of life, often held as a critical window to prevent stunting, or at later ages? We quantify the characteristics of the growth pattern of birth cohorts using the SITAR growth model and then relate the predicted SITAR parameters to infant mortality in the year of birth. In addition, we test for instantaneous effects of morbidity, proxied by infant mortality, on growth at ages 6–11. We find that infant mortality in early life did not have a strong influence on the growth pattern of children, but there were statistically significant and economically meaningful instantaneous effects of infant mortality on child height at ages 6–11 for both boys and girls. This suggests that interventions outside of the thousand-day critical window can be effective and that the secular increase in height in interwar Japan was more strongly influenced by cumulative responses to the health environment across child development rather than simply improvements in early life health.

Children's growth is an important measure of health and nutritional status that has been employed in the historical literature to track economic development and health (Harris, 1994; Hatton, 2011; Schneider, 2016, 2017a; Steckel, 1987). Since the late nineteenth century, countries all over the world have seen substantial increases in the mean stature of adults (Baten and Blum, 2014; NCD Risk Factor Collaboration, 2016). There is a vast and developed historical literature studying the factors that have led to changes in the mean height of adults over time. Recent studies have highlighted the importance of both improvements in nutrition and the disease environment in increasing adult stature (Baten and Blum, 2014; Hatton, 2014). However, there has been much less focus on how child growth has changed to make the secular increase in height possible (though c.f. Cameron, 1979; Cole, 2003; Steckel, 1987). In fact, there have been fundamental changes in the pattern of growth that children experience. Not only have children grown taller, but they experience an earlier pubertal growth spurt (and earlier maturation more generally) and faster velocities of growth during

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the growing years. Understanding how the growth pattern changed and the factors that led to changes in the growth pattern is useful because it helps us understand the secular increase in height better.

There is also considerable concern with child growth today because child stunting (the percentage of children below a certain height for age) is one of the most important indicators of malnutrition used to measure progress in the Millennium Development Goals and Sustainable Development Goals around the world (de Onis and Blössner, 2003). The causes of stunting are multidimensional and include poverty, inadequate nutrition and chronic illness from poor water supply, sanitation and hygiene (WASH) infrastructure and practices (Black et al., 2013; Headey et al., 2017b; Spears et al., 2013). These factors cause children to grow more slowly in the first two years of life, leading them to become progressively shorter than healthy children. After age two, stunted children tend to grow at rates similar to healthy children and therefore maintain their position relative to modern growth standards at least until the age of five. This pattern has led many development economists and epidemiologists to argue that there is a 1000-day critical window from conception to age 2 to intervene to prevent stunting (Victora et al., 2010).

A historical perspective can contribute to our understanding of stunting in two key ways (Schneider, 2018b). First, reductions in stunting rates in essence are driven by the same processes as the secular increase in height and change in the growth pattern discussed above (Cole and Mori, 2017). Thus, historical examples of how the growth pattern changed may reveal the kinds of policies and interventions that might help reduce stunting in the developing world today. Second, we can use historical data to test whether shocks to child health in the first thousand days are more salient for later growth outcomes than shocks occurring at later ages. There is some evidence that children can experience catch-up growth at later ages (c.f. Prentice et al., 2013; Steckel, 1987), but little is known about what factors allow for this kind of catch-up growth.

This paper uses interwar Japan as a case study to address two key questions: (1) how important was the disease environment in changing the growth pattern of children? and (2) were shocks to child health more salient for child growth if they occurred in the thousand-day critical window or at later ages? Japan is a useful environment to study these questions for several reasons. First, between the birth cohorts of the 1880s and 1980s, the average height of Japanese adult men increased by 13.9 cm (Baten and Blum, 2012), so the secular increase was strong in Japan. There was also a large decline in the stunting rate of children in Japan from over 65% in 1900 to around 6% today (Schneider, 2018b).[1] Thus, there was a radical change in the growth pattern in Japan across the twentieth century, making it an ideal case for studying changes in children's growth. Japan is also an ideal case because there is very rich historical data available. Drawing on government reports, we have constructed a panel dataset containing the average heights of boys and girls from age 6 to 21 for all 47 prefectures from 1929 to 1939. We have also collected data on a host of variables related to the disease environment and nutrition levels in each prefecture, including the infant mortality rate which we use as our primary proxy for the disease environment.

To test the influence of disease on the growth pattern, we use the SITAR growth model developed by Cole et al. (2008, 2010) to parameterise the growth pattern of historical populations. SITAR predicts parameters that measure the size, tempo (timing of the pubertal growth spurt) and velocity of each cohort growth curve in our dataset. We then take the predicted SITAR parameters for each prefecture-birth cohort and use these as dependent variables in fixed effects regressions. These regressions analyse how changes in infant mortality along with a number of other variables that capture the health conditions in the prefecture in the year of birth affected each SITAR parameter.

In addition, to address whether interventions outside the thousand-day critical window can influence growth, we estimate the effect of infant mortality and a few other covariates on the heights of children at ages 6–11. We use infant mortality to proxy the chronic disease load of children at later ages because the diseases that kill infants such as diarrhoea and respiratory diseases tend to make older children chronically ill without the same mortality consequences (Hatton, 2011; Sharpe, 2012). We use a bilateral-specific fixed effects model, which includes fixed effects for prefecture interacted with birth year, to control for any differences in initial birth conditions across prefectures and cohorts. There is greater potential for endogeneity in these instantaneous regressions, but by focusing on mortality of younger children, especially infant mortality, in the same year, we mitigate this potential bias.

Briefly, we find that health conditions in early life did not have a strong influence on the growth pattern of children in interwar Japan. However, we do find a statistically significant and economically meaningful effect of the infant mortality rate children were exposed to at ages 6–11 on child height at the same ages. Thus, the answers to our two questions are mixed. We find that the disease environment around birth did not strongly shape the growth pattern and that health shocks outside the thousand-day window were more important for child growth than those in early life. This suggests that the secular increase in height in interwar Japan was more strongly influenced by cumulative responses to the health environment at all ages across development rather than being simply the outcome of improving health conditions in early life.

1. Background

1.1. Child growth in Japan

Before getting into the specifics of our study, it will be helpful to discuss briefly the secular increase in height and changes in children's growth in Japan. Fig. 1 shows the mean male adult height of Japanese men compared with other East Asian countries and the United Kingdom. In the late nineteenth century, Japanese men were shorter than their other East Asian counterparts and 10 cm

[1] These rates are estimated from the mean national height-for-age Z-scores of children at age 6 assuming a normal distribution and constant standard deviation over time. These are rough estimates and should be taken as such.