

## Exposure to Infectious Diseases in Modern Japan II:

### The Case of Measles

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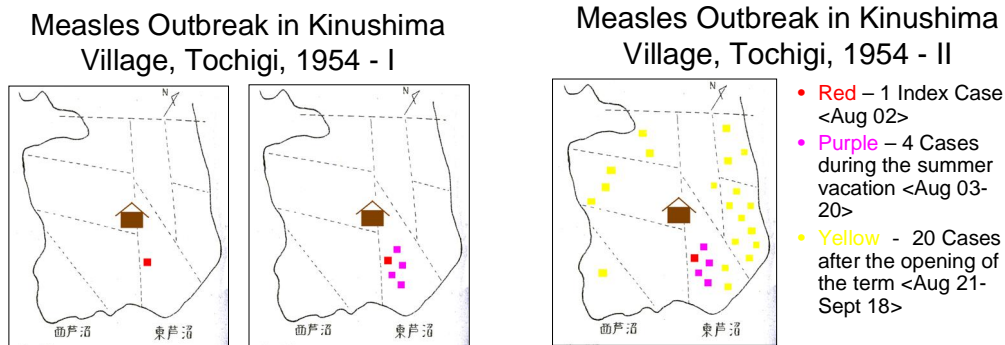
Viral infectious diseases such as smallpox and measles have played the central role in the historiography of disease and society. Due to its simple infection mechanism, life-long immunity, and easily recognized clinical symptoms, the two viral diseases have provided a marker of the historical diffusion of diseases worldwide, or the process which Emmanuel Le Roy Ladurie has called “the unification of the world by microbes.” In the 1950s and 60s, the epidemiological studies of measles acquired the concepts of endemicity and reservoir: the causative agent of measles (and some other acute infectious diseases) could survive only in a population of humans large and dense enough to sustain an uninterrupted chain of infections. In the 1970s, William MacNeil exploited these epidemiological concepts and combined them with conceptual frameworks of social science, to produce a path-breaking global history of disease diffusion from the centres of civilization to the peripheries, which were increasingly connected with the centres via commerce, conquest and migration. Works of Alfred Crosby and others have examined diseases transmissions from the Old World to the New World and the islands of the Pacific, which both accompanied and underwrote the expansion of Europe since the sixteenth century onward. Medical geographers such as Peter Haggett and Andrew Cliff have charted the diffusion pattern of measles the population of isolated islands, which were politically, economically and epidemiologically integrated into the mainland population. Measles and other infectious diseases have been utilized by historians to elucidate the creation of bio-pathologically unified or homogeneous environments, under the framework of unequal and asymmetric socio-economic relationships that existed between different regions. This paper follows those pioneer historians of diseases mentioned above, and will present an analysis of measles mortality in modern Japan.

My aim in this paper is, however, substantially different from those of McNeil, Crosby, Haggett, and others. Somewhat unfashionably, I should like to emphasize the importance of a national framework. Use of measles has so far produced two genres of studies, which are two extremes in the chronological and geographical frameworks for historical study. On the one hand, we have works of McNeil and Crosby, which are broad-brush paintings covering geographically widest possible areas, glancing diffusion across continents and oceans. On the other hand, works of Haggett and others have presented extremely fine depiction of localized disease diffusion in remote, isolated and small corners of the globe. We lack something in-between, a detailed analysis of epidemics of measles in regions of intermediary geographical size. The methodological aim of this paper is to demonstrate, in the context of modern Japan, that measles is a useful “model disease”, whose potential as an analytical tool has not been exhausted either by global or local history and that it can be fruitfully applied to the disease history of a nation.

In so doing, I should like to show that epidemics of measles in 1900-1960 were conditioned by three major historical changes Japan went through since the late nineteenth century, each of which transformed the structure of space and time of everyday life. The first is the creation of nation-wide elementary education system, which established thousands of hubs of infection all over the country. Driven by the central government’s desire to create a homogeneous nation, primary schools imposed a uniform structure of infection on the entire country. The second is the growth of large cities, particularly two large cities of Tokyo and Osaka, as the reservoir of measles virus, which radiated regular and frequent epidemics to surrounding regions. The urbanization of modern Japan resulted less from initiative of public authorities than from the growth of economy and industrialization. The third is decrease in the number of children in each household, which lowered the infection rate at home. The major force behind this shift to lower fertility and smaller family size was individual family’s decision, made in the private sphere. The creation of primary school as an apparatus of a nation-state, industrialization and economic modernization, and the arrival of the modern family with a smaller number of children – these three sets of historical changes transformed three distinct layers of spatio-temporal structure in which measles virus made parasitic living on humans. Below I will describe the three layers one by one and elucidate how changes in respective layers affected the patterns of mortality of measles. I shall conclude with some historiographical reflection upon the concept of spatio-temporal structure in the context of a wider scholarship on the social history of the body.

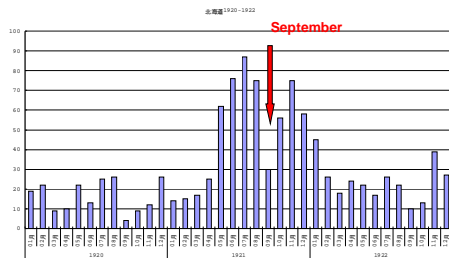
## Schools

I will first examine the impact of primary schools, which were the most important hub of infection of childhood diseases before kindergardens and nurseries became common in the 1960s.

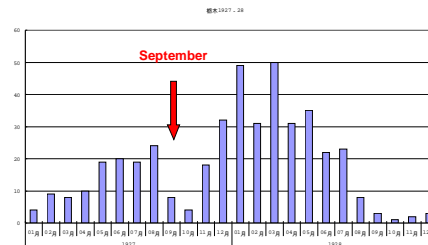


The impact of the primary school upon the outbreak of measles is best exemplified by one field survey of measles outbreak, which was conducted in 1954 in a rural village in Tochigi conducted in 1954. The village consisted of eight settlements. Some of these settlements were far apart, by three kilometers. The index case took place on 2 August during the summer holiday. Four subsequent cases, both residing in the same settlement as the index case, tickled to appear in the next three weeks. As soon as the school opened on 21 August, a fierce epidemic broke out and infected all remaining 20 susceptible schoolchildren in just four weeks, sweeping 7 out of 8 settlements. This example shows that schools did not just multiply the cases of measles, but also diffused the disease geographically. Particularly in rural areas schools acted as an epidemiological bridge between distant settlements, which would not have constituted one epidemiological unit community for children had it not been for the school.

### An Epidemic Wave of Measles in Hokkaido, 1920-22

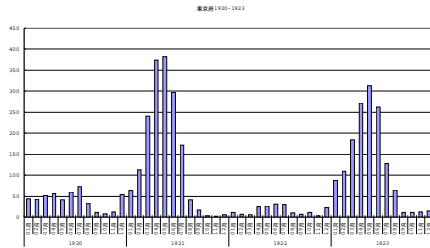


### An Epidemic Wave of Measles in Tochigi, 1927-28

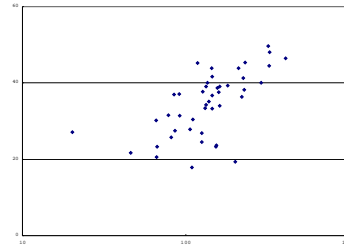


The influence of the school, or its closure, can be seen also at a regional level through mortality statistics. Figure represents the epidemic wave of measles in Hokkaido in 1920-22. There is something unnatural in this wave: it seems that the epidemics that had started in late 1920 progressed until September 1921, when the epidemic was abruptly interrupted. The epidemic appears to have resumed its momentum in the next month, reached its second peak in November and then waned. This splitting of the epidemic wave into two halves, so to speak, is explained by the influence of summer holiday, which took place during August. Epidemics progressed naturally during the term time, when a large number of children came into contacts at school and chains of infection were sustained. With the arrival of summer holiday, the infection rate became suddenly lowered, because during holiday each case could not infect as large a number of children as during the term time. The epidemic was thus suspended. When the school opened in September, the remaining infectives and susceptibles resumed the epidemic in the subsequent couple of months. There are numerous similar examples in other prefectures, in which an epidemic appears to have been interrupted in August-September.

Epidemic Waves of Tokyo, Typical Years



Population Density ( $x$ ) and Percentage of Deaths in April, May, and June ( $y$ ), 1916-25



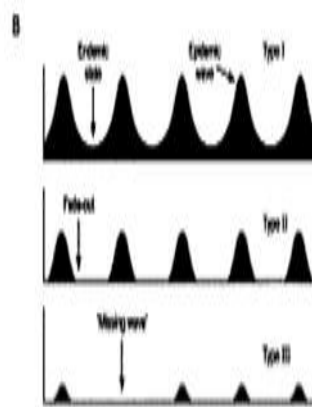
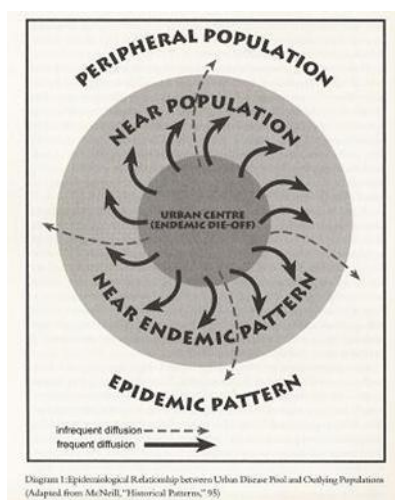
It should be noted that summer interruption was a phenomenon observed only in rural prefectures, being absent in urban prefectures. [slide06] represents epidemic waves of monthly mortalities of Tokyo. Epidemic and non-epidemic years appeared alternately. In epidemic years, a high and pointed peak appears in April or May, while in non-epidemic years the curves are very flat. No epidemic wave in Tokyo or Osaka straddled over September. The reason for the absence of summer interruption in the two prefectures is the speed of diffusion of measles in urban areas. With high population density, well-developed transportation, heavy traffic of peoples (some of whom carried susceptible children with them) and a larger size of schools, the infection rate (the number of new cases one patient can infect during the infectious period) must have been higher in urban areas. An epidemic thus progressed quickly, infected many susceptible individuals rapidly, and burned out in a shorter period. When the summer vacation started in late July, the epidemic that started in the last October had already reached its natural end.

The role of the primary school in moulding the spatio-temporal structure of measles transmission among regions of Japan was thus both uniform and, at the same time, different. Schools provided the entire nation with a hub of infection, where cases multiplied. They also acted as a centre of diffusion from which the disease reached every corner of the school-centred community. The creation of a nation-wide system of compulsory education thus established thousands of homogeneous epidemiological units covering the entire nation. Moreover, school-based unit all over the country kept the more or less same rhythm, due to their virtually simultaneous closure during summer holiday. Note well that this uniform spatio-temporal structure was created by the state, in its policy of giving rise to homogeneous nation. On the other hand, the impact of this creation of the uniform spatio-temporal structure differed markedly among rural and

urban regions, because of the difference in the velocity of diffusion. Urban regions, due to their high-speed infection, could accommodate each of their measles outbreaks within the academic schedule of primary schools, while rural ones could not. Despite the same temporal rhythm of the state-created primary schools, urban and rural prefectures exhibited different seasonality in terms of measles mortality, because societal factors outside the realm of the state policy were markedly different.

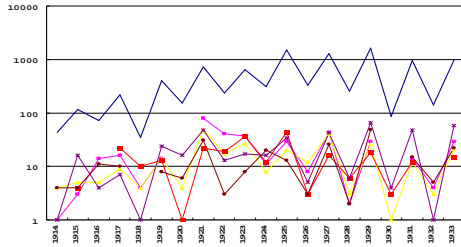
## Cities and Prefectures

# Epidemic Patterns of Central, Near, and Peripheral Populations

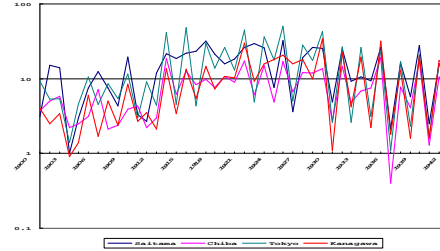


Schools explain diffusion of measles within one village or a small part of the town or city. They do not, however, explain diffusion of measles from one village to another, or one part of the city to another part. One needs infectives crossing the border of the school unit. Although it is very difficult to pinpoint the route of infection across the school areas, one can be confident that movement of infectives was facilitated by improvement in transportation and social and economic integration of neighbouring regions. I shall now turn from the sphere of policy and institution to the sphere of society, economy, and people's movement.

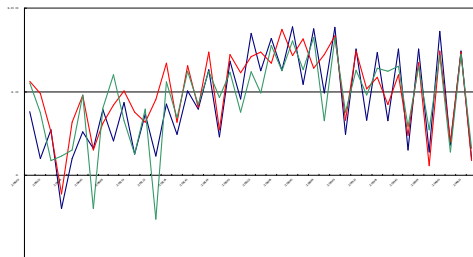
Measles Deaths, City of Osaka (Blue) and Selected Five Peripheral Regions of Osaka Prefecture (Others), 1924-33



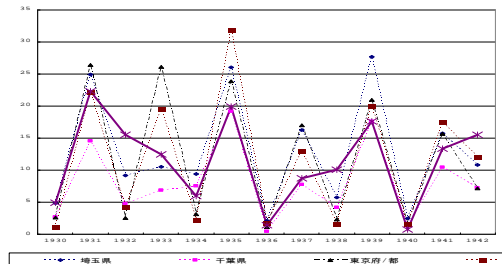
Annual Mortality of Measles (per 100,000), Prefectures bordering on Tokyo, 1900-42



Annual Mortality of Measles (per 100,000), Osaka (Blue), Hygo (Red) and Nara (Green), 1900-42



Yamanashi and Other Prefectures neighbouring Tokyo



The best place to start is a large city, with characteristic regular cycle of two years. Within one prefecture a large city progressively integrated its peripheries into performing the same epidemiological rhythm. This figure shows the annual measles deaths of the City of Osaka, and the five neighbouring regions in the prefecture of Osaka. The picture allows us to see exactly when synchronization, particularly with wider oscillation, started for each sub region. From around 1925, the city of Osaka dominated the rhythm of measles outbreaks in every region in its peripheries. Similar synchronization took place in most of the rural regions of Tokyo, which were increasingly integrated into the Metropolis. For other major cities, such obvious integration of their peripheries occurred later. Large cities were the engine of intra-prefectural epidemiological integration.

From the 1920s, inter-prefectural integration became visible, too. Here again, Tokyo and Osaka were the key area. Tokyo integrated Kanagawa from early on and

Kanagawa's dis-synchronization (or disobedience) for five years from 1923 to 28 was soon corrected. In the mid-thirties Tokyo brought neighbouring Chiba and Saitama into its epidemiological unit, although the two prefectures were still very rural regions and were unlikely achieve the deep oscillation in two-year cycle by themselves. Mountainous Yamanashi, which had no connecting chains of suburbs with the populous parts of Tokyo, remained outside the epidemiologic zone of Tokyo. Osaka's integration of surrounding prefectures had an interesting episode of the conquest of Kobe. Osaka had already brought rural and neighbouring Nara under its epidemiological dominion from the 1910s. Ironically, urban Hyogo turned out to be the major obstacle, for Hyogo's rhythm was dictated by Kobe City, which, between 1922 and 28, kept the reversal pattern with that of the Osaka City. In 1929, the year of a large epidemic in Osaka, Kobe yielded, and Kobe and Hyogo were brought into the epidemiological unit of mighty Osaka. The growth of industrial and residential cities that lay on the corridor between Osaka and Kobe in the 1920s must have acted as the background of this integration. By the 1930s, the city of Osaka dictated the epidemiological rhythm of three prefectures of Osaka, Nara, and Hyogo. Among other prefectures that bordered on Osaka, rural Wakayama could not follow the dictate of Osaka, while urban but proud Kyoto retained its glorious isolation and kept three-year-cycle, protected by its holy mountains.

The expansion of the epidemiologic realm of Tokyo and Osaka tells the story of the two cities' progressive acquirement of their respective "near population". Through geographical vicinity and the development of suburbs and transportation, areas which were by themselves rural started to beat the urban rhythm of biennial epidemics of measles.

## **Family**

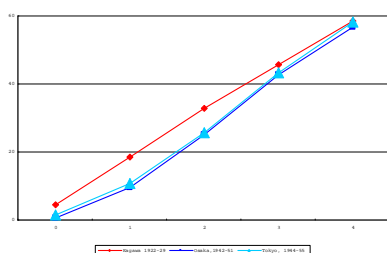
We have examined the role of school in diffusing measles in a local community. We have traced the trajectory of measles virus from major urban centres to its surrounding towns. We now turn toward the furthest end of the transmission of the disease, which is the family.

It has been well known that family is an important site of measles infection. When several susceptibles exist within a family, many of them catch the disease during an epidemic. Known as "family aggregation", this phenomenon of infection of measles from an index case to other family members has been a classic subject of epidemiological studies. Many contemporary studies of intra-familial transmission of measles have



established that in large families, children are exposed to measles at an earlier age. Reduction in family size has an effect of postponing the age at infection. Various surveys conducted in the past support this model. For example, a serological survey conducted in New Haven in 1957 revealed that children of a large family (more than three children inclusive) became seropositive to measles considerably earlier than those of a smaller family. Schools or kindergartens, which set the age for entering, explains the mechanism through which smaller family size raised age at infection. Once susceptibles were infected with measles in the school, they carried the disease to their own home and infected their younger brothers and sisters. To put it bluntly, the eldest child was likely to be infected at school, while his or her younger brothers and sisters were typically infected at home before they reach the age of school. A family with a larger number of children thus lowered the average age of infection. If we take total fertility rate as a proximate index of family size, there exist clear inverse correlation between TFR and average age at infection in data taken from various historical and geographical samples.

Accumulated rate of infection, 0-4 years, Kagawa (1920s), Tokyo and Osaka (1940s)



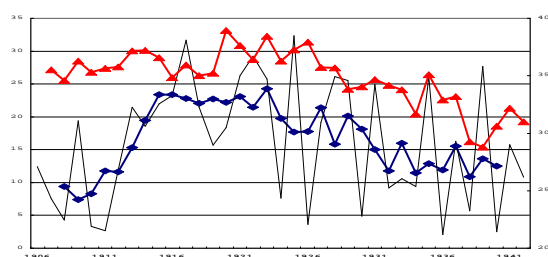
Ratio of age-specific case fatality rates (2yrs =1.0)

0 yr	7.89	• (calculated from age-specific mortality data and age-specific infection data for Kagawa, 1922-29)
1 yr	2.83	
2 yrs	1.00	
3 yrs	0.52	
4 yrs	0.28	
5 yrs	0.43	
6 yrs	0.02	
7 yrs	0.01	

One set of Japanese historical data confirms that this model is valid. To begin with, the crude birth rate started to decline in the 1920s: the national figure peaked at 36.2 in 1920 and steeply declined to 26.6 in 1939. The survey of Kagawa sent questionnaires to those who were born 1922-29, while the data for Tokyo and Osaka were about those who were born in the 1940s and early 50s. All samples were sufficiently large, all exceeding 10,000. Individuals born in the 1920s were more likely to get measles earlier, at the age of 0 and 1, while for those born in the 40s the infection was postponed until they became 2 years old. With declining fertility and the decrease of the number of new addition of children per family, a larger proportion of children enjoyed the epidemiological privilege of being the first child of the family and of postponing exposure to measles at a later age.

The changing age-profile of the patients suffering from measles had a profound effect: the decrease in its mortality. Fatality risk of measles was inversely related to age at infection. If contact with measles were delayed, mortality could be reduced. According to our data of Kagawa, Tokyo and Osaka, the rate of infection at the age 0 and 1 went down as shown in the slide18. This might look a minor change, but its impact on the mortality of measles in the 1920s and 30s was huge. If one calculates ratios of age-specific case fatality from the data from Kagawa in 1922-29, one finds it declines precipitously with age: getting measles before at the age of 1 was 2.8 times lethal as the infection at 2 years old, and infection during one's infancy is about 8 times as fatal. A small fraction of decrease of the chance of infection at these high-risk ages must have led to a substantial improvement in measles mortality. [slide 20] The decline in fertility in Japan in the 1920s and 30s thus correlated with the decline in moving average mortality of measles.

Measles Deaths (5-year moving average),  
and Crude Birth Rate (Saitama 1906-1941)



Our observation that age at infection to measles rose in the 1930s has an important implication for understanding the change in spatio-temporal structure of modern Japan. Our findings tell that children were allowed to mature more slowly by postponing the infection, due to a less crowded domestic space. This is, so far as we have found, the only change that resulted in reducing the risk of infection to measles. At regional level, metropolitan dominance and development of interconnectivity lead to progressively shorter periodicity until many regions exhibited biennial periodicity in the 1930s. Great difference in the risk of dying from measles exists between living in a region that had major outbreak in every two years, and one which had an epidemic in, say, every five years. Moreover, introduction of compulsory education meant that every child was enforced to experience a great hazard of infection at the age of 6, and every younger brother and sisters of him or her should expose themselves to the risk of measles introduced to the family from the school. At these two spatial levels, modernization led to the increase in the risk of getting and dying from measles. At the domestic space,

however, the tempo of infection slowed down that led to the reduction of mortality. For the three layers of space, region, locality, and the family, within which an individual lived, the epidemiological flow of time changed into opposite directions: for the outer two layers of region and locality, one was exposed more hectic life, visited by measles epidemic, while at the family, his or her

## **Conclusion**

I hope my analysis has shown that the contour of time and space, seen through the lens of measles infection, went through profound and complex changes from 1900 to 1960, in time of rapid modernization in Japan. The central government of the new nation-state created thousands of homogeneous epidemiological units in the form of primary schools. Economic modernization encouraged the growth of large cities and traffic of people and pathogens between the metropolises and their neighbouring areas. Individual couple's choice for smaller number of children affected the age structure of the family's younger members and raised the age at infection.