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Who saved babies?

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Urban laboring poor against Infant Mortality at Osaka city of the early 20th century : Who saved babies? *

Emiko Higami[a][†], Kenichi Tomobe[b][†] and Makoto Hanashima[c][†]

Abstract

The average infant mortality rate (IMR) was 155.4 in rural areas in Japan, and IMR in Osaka city was 231.6 during 1906 to 1910. The outstanding level of IMR in Osaka city might have been influenced by somewhat negative urban factors, which we can call the "urban penalty." Dr. Hiroshi Maruyama discovered the α-index in 1938. The α-index represents infant mortality number divided by neonatal mortality number. After all, Maruyama set one month after birth as a boundary to divide endogenous and exogenous. The α-index shows a qualitative measure of infant mortality. Post neonatal mortality was increased due to acquired diseases such as diarrhea, pneumonia and beriberi. This shows that the effect of the urban penalty was raising the α-index. The α-index of the industrial zones shows that bad maternal conditions affected endogenous factors. Most mothers suffered from a deficiency of breast-feeding capability. The first reason was anemia. The second reason was mothers' ignorance about breast-feeding. The third reason was mother's illnesses. They had to rely on bottle-feeding without any knowledge to handle artificial milk. Those babies often died from diarrhea or pneumonia.

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Introduction

Statistics officer, Yasunori Nikaido, first highlighted the issue of infant mortality in Japan in his 1914 article entitled "The Characteristics of Infant Mortality in our Country."[1] Between 1906 and 1910, the average infant mortality rate (IMR; infant deaths per 1,000 live births) was 188.7 in urban areas (cities with more than 50,000 people) and 155.4 in rural areas. Nikaido assumed it was urbanization itself that contributed to the higher IMR of urban areas, especially since the average crude birth rate was a full 10 points lower in urban areas than in rural ones. The existence of negative urban factors is also suggested by the fact that when the crude birth rate was similar between two urban areas, for example 20.7 in Tokyo and 20.2 in Osaka, the IMR was considerably lower in Tokyo (176.4) than in Osaka (231.6), indicating that some form of additional "urban penalty", such as population density and air pollution, was at play in Osaka. Besides these structural factors, it appears that the higher rate of breastfeeding, a behavioral factor, in rural areas contributed to the higher urban IMR. S. Scott and C.J. Duncan note that humans produce milk with a very low nutrient density and have low stress of lactation. They state, "It is usually assumed that this lactation strategy has been determined by the very slow growth rate of the human infant, which in turn has been naturally selected as providing the optimal time for the growth, development and training of a large brain."[2] Walhout detected, in a Dutch province, a change in breastfeeding patterns between 1875/79 and 1895/99 that was associated with an increase in the IMR caused by diarrhea and other acute diseases of the digestive system, indicating a decrease in breastfeeding practices.[3] Also, according to J. Vogele, T. Halling and L. Rittrtshaus, feeding practices were the key determinant of infant mortality in early twentieth-century Germany, when the transition to so-called artificial nutrition took place and more than 70% of all infant deaths resulted from gastro-intestinal disorders.[4]

In 1938 Dr. Hiroshi Maruyama introduced the α-index, which divides the number of infant deaths by the number of neonatal deaths[5]. At that time, the majority of neonatal deaths were caused by endogenous factors and congenital feebleness, such as preterm birth, congenital weakness, malformation and peculiar disease, and death occurred immediately after birth. Post-neonatal deaths, on the other hand, were caused by exogenous factors such as diarrhea and infectious and respiratory diseases. Accordingly, Maruyama set one month after birth as the dividing line between endogenous

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[1] See Nikaido(1915)
[2] Scott S. & Duncan C.J., 2002. Infancy, Chap. 8. *Demography and Nutrition: Evidence from Historical and Contemporary Population*. Oxford Blackwell Publishing, p.144.
[3] See E.C.Walhout(2010)
[4] See J.Vogele, Halling and Rittrtshaus (2010)
[5] See H. Maruyama (1976). Japan's vital statistics present neonatal mortality as the number of deaths in one month, and we therefore use NMR in this way.

and exogenous factors. Thus, the α index is a qualitative measure of infant mortality.

Figure 1. Changes in infant mortality rate (IMR) , neonatal mortality rate (NMR) and
α-index（IMR/NMR） in Osaka city,1906－1934 and Japan, 1899-1934

Source: *Jinko dotai tokei [Vital Statistics of Japan].*
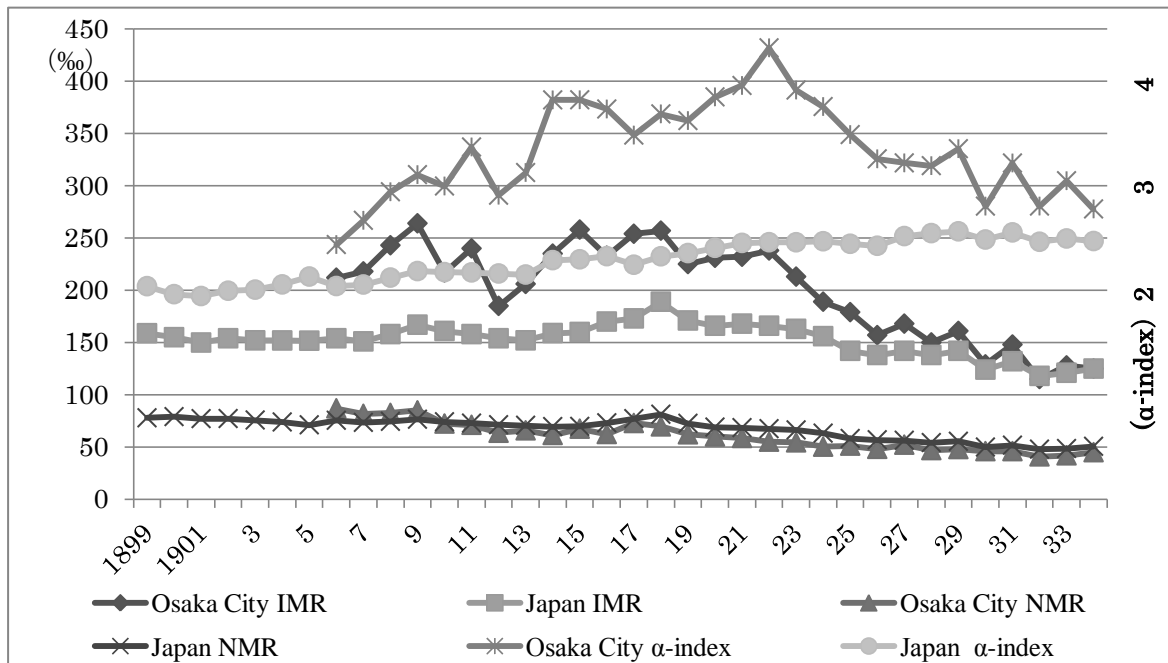
S. Ito also reported post-neonatal mortality was increased by diarrhea, pneumonia and the acquired disease beriberi.[6] Thus, an urban penalty would likely increase the α-index score. Between 1907 and 1932, he conducted infant nutrition surveys and found a low breastfeeding rate associated with the highest IMR in cities. For example, infants fed artificial milk had an IMR 1.8 times higher than that for infants fed breast milk. Figure 1 shows the IMR, neonatal mortality rate (NMR, per 1,000 live births) and the α-index scores for Japan and Osaka city. The IMR of Osaka city as a whole was above the national average for one period during the early Showa era (1926-1945), while the city's α index score for was considerably higher than the national average. When comparing the α index of Osaka city and the national average, the α index for Osaka city peaked at 4.3 in 1922, which was in the Taisho era (1912-1926) when the α-index scores were the highest in Japan generally and indicate urban penalty.

The purpose of this paper is, firstly, to examine in detail the cause of the comparatively higher IMR of Osaka city. Figure 2 shows the IMR from diarrhea (per 1,000 live births) of Tokyo,

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[6] See S.Ito(1998)

Osaka, Nagoya and the national average. Between 1908 and 1926 the IMR from diarrhea in Osaka fluctuated from 40 to 70, and diarrhea accounted for most deaths, namely, one-fourth to one-fifth of all infant deaths. The α-index was larger than national average because of these infant deaths from diarrhea. The average IMR of Osaka city was 219.3 during that period, with the IMR from diarrhea playing a major role in the overall IMR. As many mothers in Osaka were unable to breastfeed their babies, they were fed bottled milk, and some suffered malnutrition and consequently died of diarrhea. Women's labor issues might have contributed to the decreased rate of breastfeeding. There were many spinning factories in the Osaka area around 1900. A female employee generally started work at the factory at 12 or 13 years of age and continued working there for around 1o years or so before getting married and becoming a mother. In this research, we look first at how working practices in the factories may have negatively affected breastfeeding practices, and second, we examine how Osaka city managed to reduce its IMR in the 1920s so that it fell to 143.1 by 1928, which was comparable with the national average.

Figure 2. Infant mortality rates from diarrhea of Osaka City, Tokyo City
and Nagoya City, 1906-1936.   Osaka Prefecture and Japan,   1899-1936
Source: *Jinko dotai tokei [Vital Statistics of Japan].*
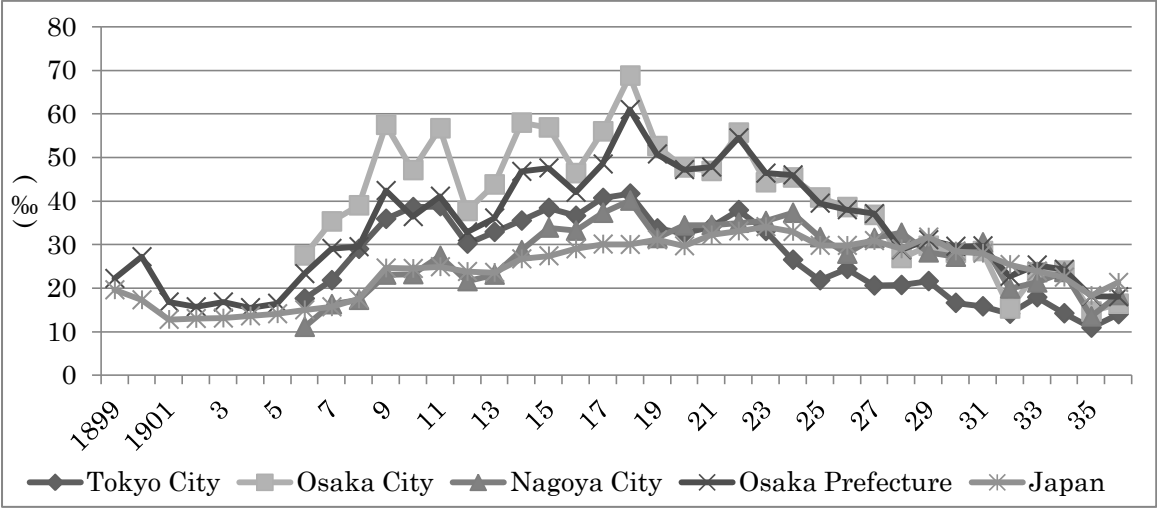
Variations in infant mortality between different areas of Osaka city

Osaka city was formed in 1889 with four wards (*ku*)—Kita, Higashi, Nishi, and Minami—which were all affluent commercial wards. Outside of the city by Osaka Bay, Nishinari district had some

areas with high IMRs. These areas overlapped with the industrial part of the city, and in 1897, 28 outlying towns and villages, including Konohana Minato and Taisho were incorporated by the city[7].

Map Infant Mortality Rates of Districts in Osaka city, Nishinari-gun and Higahinari-gun, 1920
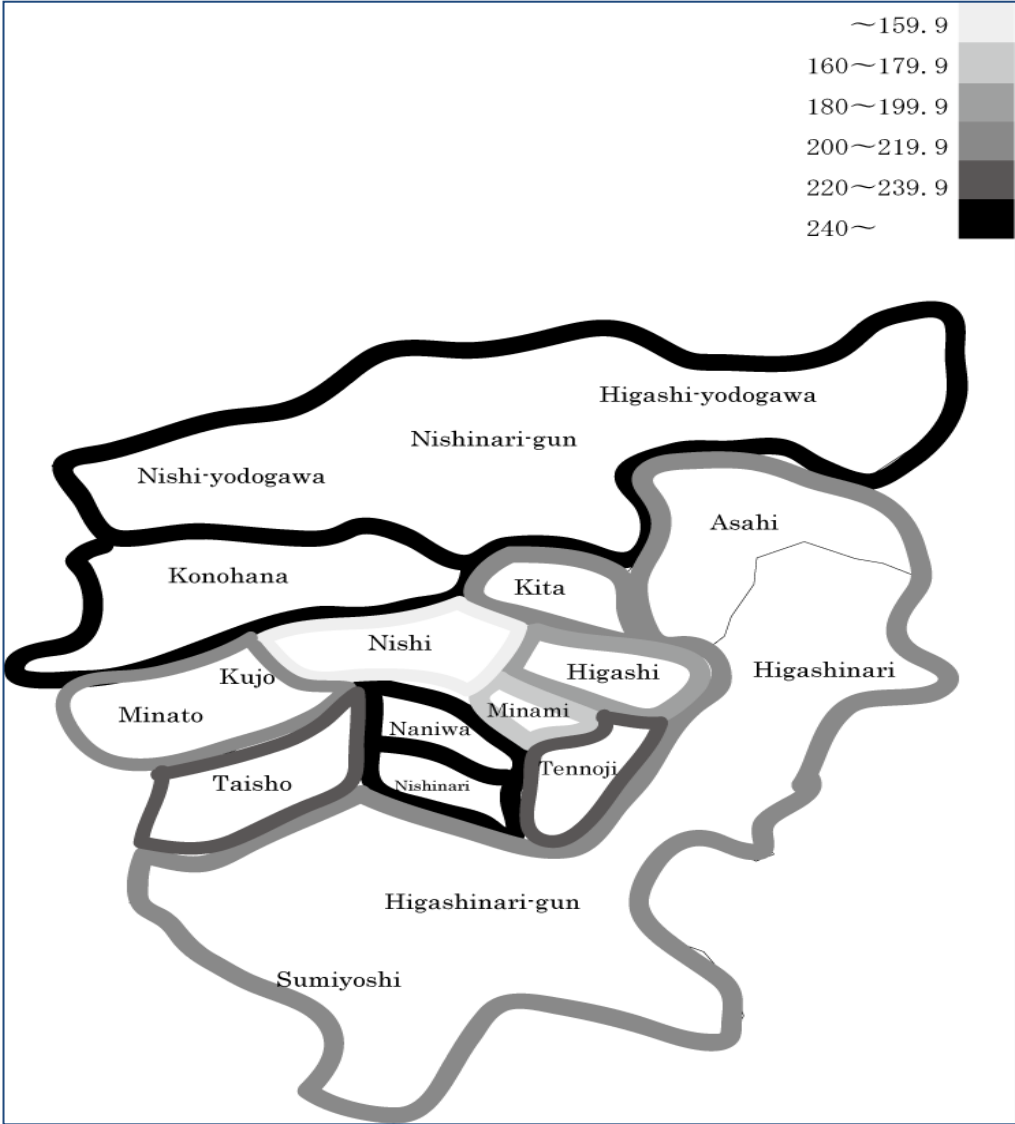
Source: Osaka-fu eisei siryo 2 [The Osaka-Prefecture hygienic report, vol.2 (Osaka Prefecture police)] 1923

At this time, Nishinari district was divided into two areas, Nishinari and Yodogawa, and the Bay area was included in Nishi ward in order to develop its trade. Later, in 1925, Osaka city incorporated Higashinari district and Nishinari district.

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[7] We use the average IMR of 1914-1918 and the diarrhea IMR of 1916. Osaka city was composed of 15 districts in the period 1932-1943.

Table 1. Comparison of α-Index, IMR and IMR from diarrhea of each district

in Osaka city in 1920-1935

Ward/District	1920(1)			1935(2)			(2)-(1)	
	IMR(‰)	Diarrhea IMR(‰)	α-Index	IMR(‰)	Diarrhea IMR(‰)	α-Index	Diarrhea IMR(‰)	α-Index
Kita	204	45.6	3.102	104	14.9	2.837	30.7	0.265
Konohana	271	61.8	3.210	122	15.2	2.869	46.6	0.342
Higashi	185	44.8	3.036	99	8.7	2.489	36.1	0.547
Minami	176	48.6	3.378	103	10.4	2.614	38.2	0.765
Naniwa	275	65.9	3.803	129	19.1	2.731	46.8	1.072
Tennoji	226	63.3	3.474	102	13.0	2.543	50.3	0.931
Nishi	133	34.4	2.980	82	8.6	2.278	25.8	0.702
Minato	217	58.1	3.284	126	21.0	2.605	37.1	0.679
Taisho	223	57.2	3.151	130	18.8	2.926	38.4	0.224
Nishinari	254∗	61.7	n/a	140	22.1	2.740	39.6	
Nishiyodogawa				138	24.7	2.741	37.0	
Higashiyodogawa				127	22.4	2.810	39.3	
Asahi	213※	51.1	n/a	120	16.5	2.617	34.6	
Higashinari				144	23.8	2.963	27.3	
Sumiyoshi				96	13.0	2.554	38.1	
Osaka City	209	52	3.272	122	18.1	2.726	33.9	0.546

Source: (1) *Osaka-fu eisei siryo 2 [The Osaka-Prefecture hygienic report, vol.2 (Osaka Prefecture police)]* 1923, 20-29. (2) *Osaka-shi eiseikumiai-betu syusan shibo nyujishibo tyosa [Survey of births, deaths and infant deaths by hygiene districts of Osaka city (Osaka city health bureau and Osaka infantile protecting association)]* 1937, 19-49.

Note: ∗ Nishinari-gun, ※Higashinari-gun. We use average IMR of 1914-1918 and Diarrhea IMR of 1916 of two districts.   Osaka city was composed by 15 wardts during 1932-1943.

The biggest slums were in Naniwa, in the northern part of Nishinari and the western part of Tennoji. From 1920 to 1935, the eastern part of Tennoji changed to a residential area for salaried workers and Higashinari formed a new small-scale industrial zone. Sumiyoshi and Asahi still had relatively large areas of farmland. Overall, the IMR, IMR from diarrhea and the α-index of slum and industrial areas were higher than commercial, agrarian and salaried workers' residential areas.

Next, comparing Naniwa which had the highest IMR and Konohana which had the second highest IMR, Naniwa had a high IMR and a high α index score, whereas Konohana had a high IMR but a low α index score. This tendency in infant mortality was also seen in the industrial Bay area, such as Taisho. The low α index score indicates that neonatal mortality was high, where infants died from congenital feebleness. The industrial zones had the worst two indices scores, indicating maternal conditions were the poorest. Naniwa had considerably more infant deaths from beriberi and meningitis caused by breastfeeding and thus its α-index was high.

The IMR of Naniwa was more than twice that of Nishi which had the lowest IMR. However, 15 years after, the differences between two distracts had shrunk to a 1.57-times difference. Moreover, the α-index score for all districts had reduced to less than 3. The IMR and α index values had been equalized. This occurred because an Osaka prefecture survey had clarified the cause of high infant mortality, and the prefecture and Osaka city actively introduced measures to reduce infant mortality.

Parents' occupation and IMR

The first national census in 1920 showed that 63% of the population of Osaka city was composed of people who originated from another prefecture. Working women accounted for 23% of the city's female population aged 14 to 59.

Table 2.　Number of working population of unmarried/married women and
their main occupations,　1920

	Working population (person)	%	The Main Occupation
Single	49,243	55	Factory workers (Spinning, Textile, Cigarette), Nurse, Operator, Attendant in restaurant, Licensed prostitute
Married	21,623	24	Retailer, Used-goods, Teacher, Midwife
Divorced Widow	18,732	21	Sewer of Japanese clothes, Day laborer
	89,598	100	

Source: *Dai 1kai kokusei-tyosa Fuken no bu Osaka-fu dai 3[The First National Census Part of Prefecture No.3 Osaka (Statistic bureau of Home affairs Ministry)],* 1926.

Table 2 shows the main occupations among the female workforce: 13% were employers, 7% were employees and 80% were workers[8]. Most employers were selling goods and were around 40 to 44 years of age. While retailing goods at stores in their houses, they were able to keep house at the same time. Women engaged in commerce could add to their workload and advance to more responsible positions as their children grew. This meant that when a woman working in commerce had to care for her baby, she generally did not have to work hard. When she was under 35 years of age, she was likely an unemployed subordinate, but tended to be a working woman between 35 to 40 years of age.   In terms of women who were employees, most were public employees like teachers. The majority of female teachers were aged 25 to 29.

Table 3. The working population rates of Industrial /Business activities and IMR, 1930

Ward	Industrial employment rate(1)（％）	Business employment rate(2)（％）	IMR(3)(‰)
Kita	37.46	41.81	139
Konohana	48.27	31.23	122
Higashi	28.27	50.22	95
Nishi	21.78	59.05	113
Minami	25.07	58.15	109
Naniwa	43.28	42.17	131
Tennoji	34.81	39.91	144
Minato	40.29	32.24	122
Taisho	40.29	32.24	134
Nishinari	44.98	35.66	132
Nishiyodogawa	53.98	24.90	134
Higashiyodogawa	51.38	26.50	138
Asahi	54.62	27.15	124
Higashinari	54.62	27.15	143
Sumiyoshi	28.97	39.97	115
Osaka City	40.36	37.88	128

Source: (1)(2)- *6 Dai Tosh Tyukan jinkou [Daytime population in Japanese six main Cities(Statistic bureau of Home affairs Ministry)]*1936, (3)*Osaka-shi eisei sikennsho jigyo seiseki gaiyo[Achievement Report (Osaka City Hygiene Laboratory 1931)],*1933

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8 Employees and workers were the differences by type of wages and status.

The distribution of occupations in Osaka city in 1930 can be broken down as follows. The industrial sector employed 40.36% of workers, the commercial sector 37.88%, the public sector and self-employed 8.26%, the transportation sector 6.36% and primary industry 1.63%. Table 3 shows a comparison between the working population rates in industry and business (commercial) in each administrative ward and compared IMR. Regression analysis, with the IMR of each ward as the dependent variable and the industrial and business employment rates as the independent variables, reveals that the business employment rates correlate negatively with the IMRs. Retailing goods in a shop accounted for 60% of commercial employment. As the national census mentioned, women engaged in retail from a shop in their house could continue working while also caring for their baby and keeping house. The other group for whom this trend was clear were salaried business men employed in offices whose wives were homemakers and could therefore breastfeed their babies. It was for these reasons that the IMR among commercial families became low.

Not surprisingly then, industrial employment rates correlated positively with IMRs. If factory laborers became mothers and preferred to continue working, it was hard for them to do so, as there were no day nurseries in the factories. Because they had to work 10 to 12 hours a day, the babies had to have artificial milk while the mothers were working. Moreover, because many laborers' wives working in the spinning factories came from other prefectures, they did not carry on the traditional child care practices of their own mothers.

Table 4. The co-relationship between working population rates and IMR :

Industry and Business

Y=IMR	Industrial employment rate	Business employment rate
Occupation rates	0.782＊	-0.783＊
t-value	2.8596	-2.8614
R^2	0.3861	0.3864

Note: ＊ 5％significant（OLS）

Female spinning factory workers and nutritional factors

In 1870, The Ministry of Defense built *Hohei Kosho*, the army arsenal, to the east of Osaka Castle, and the plant started producing ammunition and ironware. The following year, the Osaka Mint

Bureau was established in Tenma to produce coins and manufacture sulfuric acid and caustic soda. In 1881, the Osaka Steel Company was founded on the northern bank of Aji River. In 1883, Osaka Spinning Limited went into business at Sangenya in Nishinari district and started spinning manufacturing with 10,000 bobbins. The company had high dividend-yielding stocks. The company introduced nightshifts to fully utilize the machines and maintain good profits, and it was soon joined by many other spinning factories built in the same district or in the Bay area.

A recruiter for the spinning company recruited poor farmers' daughters in the rural prefectures of western Japan. Some spinning companies had a textile weaving factory where over 1000 employees worked, 78% of who were girls or young women. Female workers under the age of 14 accounted for 10% of all spinning factory workers, 15-20 years olds accounted for 36%, 20-25 years olds 20%, and over 25 years old 12%. Single women lived in dormitories at the factory, and they worked 11-hour days, from 6 in the morning to 6 at night or did a nightshift, with only a 1-hour break. Nightshifts were particularly hard for the women workers and many lasted only 1 year in the factories. Those who stayed in Osaka often changed jobs to other spinning factories or other types of factories. It was not long before there were shortages in the spinning factories and the recruiters would need to start looking again. This rapid turnover ultimately forced the companies to improve the meals and laundry services for workers so that they could retain them. However, until then, the meals did not contain enough protein and fat, and the workers were not taught how to cook, launder or keep house by the dormitory staff. They therefore lacked knowledge not only on child-rearing and women's hygiene, but also on breastfeeding.[9] In 1926, the Factory Law was amended to prohibit women working nightshifts and went into effect in 1929.

When Osaka prefecture released a report in 1923 on infant nutrition over the past 6 years in Kujo, Nishi ward, 58.6% of infants who died from diarrhea had been fed artificial milk or mixed artificial and breast milk, despite infants fed by artificial milk or mixed artificial and breast milk amounting to only 34.9% of all infants.[10] Even though artificial or mixed nutrition clearly carried more risks to infants than breastfeeding, 674 mothers were recorded as changing from breast milk to artificial or mixed milk during that period. Of these 674 cases, 296 of the infants survived and 378 died. As reasons for this change in nutritional behavior, 49.8% of the mothers who switched to artificial or mixed milk did so because they had insufficient breast milk or the infants did not suckle properly. Women in the spinning factories worked so hard that they gradually became weak and anemic, causing a lack of breast milk, so the infant would become malnourished.[11] [12]

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[9] See Uno(1915)
[10] See Kunisawa(1926)
[11] See Konishi(1928)

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In addition, mothers were not knowledgeable about breastfeeding. When they had their first or second baby, their breast milk was often limited because they did not know about the physiology of breastfeeding. Sixty-three percent of mothers whose infant died had given their child diluted condensed milk merely based on their intuition and did not know that the mammary gland needed suckling stimulation from the infant to give sufficient milk. As an example, although mothers needed to persevere letting the baby suckle the breast for 7 to 10 days, they often gave up breastfeeding within 2 to 3 days and started using condensed milk, which was sweet and easy to feed. Babies preferred the condensed milk and stopped suckling the mother's breast. If the mother did not breastfeed for 2 to 3 weeks, she would no longer lactate. Almost all mothers were found to have changed their feeding method within 1 month after giving birth.

Table 5. The survey of diseases coming from nutritional change in Kujo 1923

	Died infant's mother	Grown infant's mother	（％）
Beriberi	80	61	54.7
Mastitis	9	9	7.0
Digestive disease	7	7	5.4
Nephritis	7	3	3.9
Heart disease	5	4	3.5
Tuberculosis	1	5	1.9
Other	36	61	23.6
Total	138	120	100.0

Source: Kunisawa,T.Nyuyouji hogo ni kansuru hokoku*[Report on the protection of infants and children]*1926, 129-132.

The survey also found that 258 mothers (38.3%) changed the way they fed their infant due to illness. Table 5 shows a breakdown of the mothers' illnesses: 18 mothers were suffering from possible mastitis and 141 from beriberi, the most prevalent illness, which accounted for 54.7% of all maternal illnesses. Beriberi is caused by a shortage of thiamin and could not be treated. Once it became widely known that beriberi could be transmitted to the suckling infant, a woman who had swollen legs because of light kidney trouble after childbirth often hastily judged herself that she had beriberi and stopped breastfeeding. So, many mothers did not have accurate knowledge about child-rearing. Infants continued to die because the mothers were not being educated in child care,

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[12] Osaka-shi Shakai-bu.1922.[Osaka city social research bureau] "*Rodo chosa hokoku 13 Shoko hoken*" *[Labor Research Series Report, No.13 :Labor's health] 1923.*

housekeeping or hygiene by anyone in their families or dormitory staff.

Education for poor mothers

Hikoichi Motoyama, then President of Osaka Mainichi Newspaper, formed the Osaka Mainichi Newspaper Charity Organization to promote medical care in 1911. He learned that many pregnant women among the poor did not receive care from a midwife during childbirth. In 1914 the Organization started to offer free midwifery services to poor pregnant women who did not otherwise have access to a midwife. The women who applied needed to ask the police department for a ticket to use the midwifery services. The midwife conducted prenatal check-ups and provided care during the delivery. Osaka prefecture also appointed Shigejiro Ogawa as an adviser in 1918 and he established a regional nongovernmental relief service system[13]. In 1920 he began assistance for pregnant women who would not be able to provide care for their infants. These women were malnourished and did not have access to a midwife or treatment. In 1923 the charity, in cooperation with the relief service system, employed 40 midwives, arranging for one part-time midwife to work in each district. The midwife helped bathe the newborns for 7 days after birth, took care of the newborn's umbilical cord and when a mother found it difficult to obtain enough breast milk, taught the mother to easily dilute a bottle of milk and sold the mother milk at low cost.

The charity's midwives handled 373 cases, and in 1929 for example, of the 333 babies born, 171 celebrated their first birthday. Notably though, 100 other infants moved with their mothers, often with the family slipping out of town quietly, although some were adopted and some went to the mother's home town. Of the 373 infants delivered, 62 died: 21 died from a congenital defect, 19 from diarrhea (2 were breastfed and the remaining 17 babies were fed artificial or mixed milk), 6 from pneumonia, and 7 from unknown causes. If we assume that all the 100 babies that moved away with their family survived, then the IMR of babies whose mothers used the charity were 186, which was actually higher than the IMR of 161 for Osaka city in 1929. Table 6 shows the extremely poor housing conditions in which these babies were born and raised; they were overcrowded, dark and draughty, with poor sanitation.

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[13] The regional relief service supported elderly people and children who either had no caregivers or were not able to support themselves. Also, poor families earning less than 25 yen per month could receive the service even if all family members worked.

Table 6. Types of housing of pregnant women who used midwifery services provided by Osaka

Mainichi Newspaper Charity Organization in 1926

	Three households per house	Two households per house	One household in a house			Cheap lodging house	Boat on sand	Unknown	Total
			1 room	2 rooms	3 rooms				
Pregnant women	8	83	14	66	16	25	3	12	227

Source: *Osaka Mainichi Shinbun Jizendan 20 Nenshi [A   twenty-year history of Osaka Mainichi Newspaper Charity Organization],* 1931, p.185

Parturient women visited the charity's midwife to deliver the baby without having any prenatal checkups. Women who were 9 months' pregnant accounted for approximately half of all who used the free midwifery service. They were employed as maids or factory workers. Women who were factory workers had usually worked hard, having a side job not only before childbirth but also soon afterwards. The charity's midwives helped with 2,132 cases (2,107 pregnancies) during the period 1914-1930: normal deliveries 1,751, preterm deliveries 87, 41 miscarriages and 141 stillbirths.

Osaka city established the Osaka City Child Guidance Clinic in 1918. The head of the Clinic, Hiraku Sandaya, regarded infants as being included in the term 'child' and clinic instructors therefore visited homes where mothers did not know how to care for their babies and provided them instruction[14]. The Clinic was reorganized into Osaka City Nursery in 1924. The visiting nurses chose houses that appeared poor and unable to access medical care. They visited 5 times within the first 100 days of birth, instructing mothers how to breastfeed or how to safely feed milk to infants who could not breastfeed. They taught nutritional improvement and prevention of beriberi and meningitis. If they found the babies were sick, they suggested the mothers use a free ticket they provided (available to families earning less than 800 yen a year) to go to the clinic in Osaka City Nursery. These early treatments saved the lives of many infants.

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[14] The instructors had to break down the superstitions surrounding child care. For example, superstition meant that a newborn's first drink was not his mother's milk but   an infusion of medicinal herbs, saffron, rice gruel, salt water, sugar water, raw milk and so forth. Only one-fourth of all mothers gave her newborn her own breast milk.

Figure 3. The distribution of causes of infant deaths in Osaka city. 1906-1930 unit：‰

Source:*Jinko doutai tokei[Vital statistics of Japan],Shiin tokei[Cause-Specific Death Statistics of Japan]*
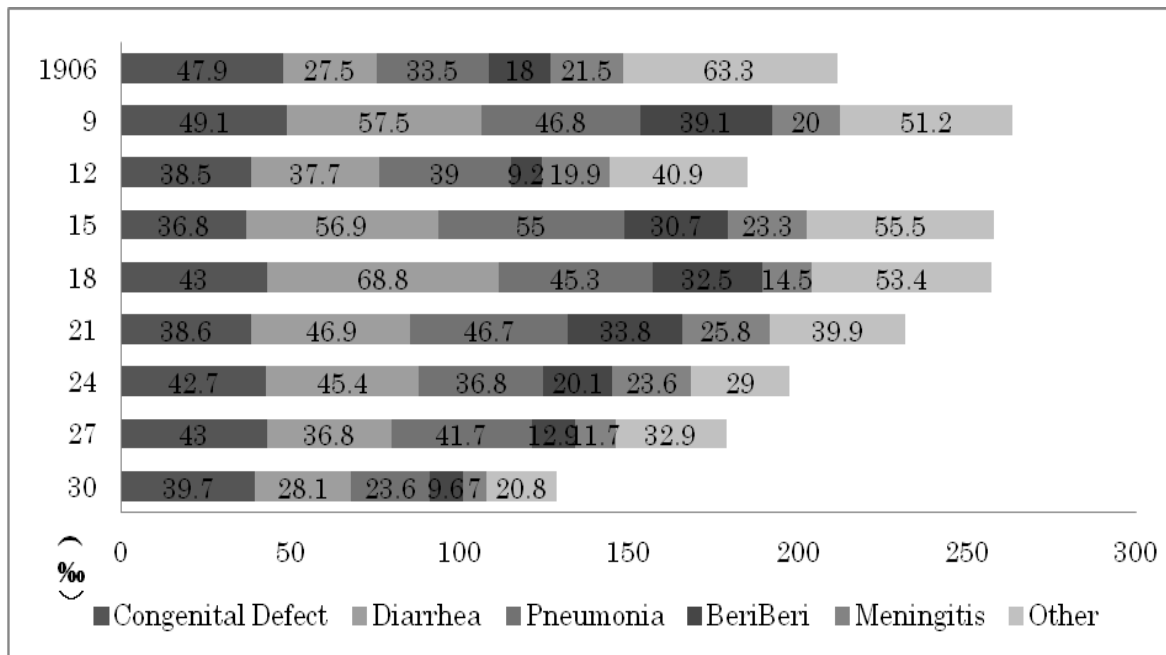
Thus, as can be seen in Figure 3, the IMR from diarrhea of Osaka city was reduced from 68.8 in 1918 to 28.1 in 1930, a drop of 40.7. The part-time midwives provided by the newspaper's charity and the visiting nurses of Osaka City Nursery were proactive in the prevention of infantile diarrhea. Mothers needed to have knowledge about nutrition and child-rearing, especially how to breastfeed and dilute artificial milk safely and hygienically.

Conclusion

The industrialization of Osaka occurred mainly though growth of the textile industry. Young women from rural areas joined the spinning factory workforces. Once there, they worked long hours and had poor diets, which caused illnesses like anemia. After childbirth, their poor general health condition often meant they found breastfeeding difficult. In addition, long hours of standing while pregnant at work tended to cause premature delivery. The young women's mothers tended to live far away, unable to teach them how to raise children, maintain hygiene and keep house. For these reasons they did not understand the physiology of breastfeeding—a desperate problem since their baby's lives

depended on them having such knowledge. The IMR in the industrial areas was higher than in other areas and the α-index was lower than in the slum, indicating poor maternal health conditions associated with endogenous factors and congenital feebleness. In addition, most mothers could not produce enough breast milk and had to depend on bottle-feeding without any knowledge of handling artificial milk. Their babies died from diarrhea or pneumonia because they were malnourished. However, once charitable and later municipal efforts began in Osaka, the IMR rate gradually improved as care and instruction for the mothers improved infant survival rates. The midwives and visiting nurses offered prenatal checkups, childbirth assistance, bathing the newborns, feeding instruction, milk at low cost and free clinic access. Sometimes just with them visiting, mothers could rest for a while. These early treatments and efforts saved the lives of many infants. Later as the standard of living gradually rose, households could manage on the husbands' wages and wife's wages for piecework done at home, and the women rarely returned to factory work. The lives of the infants depended on their mothers having adequate knowledge of nutrition and child-rearing. Ogawa and Sandaya's administrative talents and Motoyama's organizational skills were crucial in the fight to reduce infant mortality. As a result of all these efforts, the IMR from diarrhea of Osaka city was reduced in a relatively short space of time from 68.8 in 1918 to 38.6 in 1926.

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