

広島県の COVID-19 パンデミック前および中における 病児対応型保育施設の利用者数と一般感染症の動向に 関する重回帰分析

Multiple regression analysis of the number of users of nurseries for children with mild illness and trends in common infectious diseases before and during the COVID-19 pandemic in Hiroshima, Japan

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Abstract

Most Japanese daycare centers do not accept ill children, even if they only have minor symptoms. Nurseries for children with mild illness have been developed (mostly in urban areas), but use of these nurseries dropped sharply during the COVID-19 pandemic. This study aimed to clarify the reason for the decreased use of these nurseries. Data on trends in common infectious diseases reported by sentinel medical facilities to public health centers in Hiroshima Prefecture, Japan from January 2018 to March 2021 were provided by the Hiroshima CDC (Center for Disease Control and Prevention). The number of monthly users of nurseries for children with mild illness in the 23 municipalities in Hiroshima Prefecture over the same period was obtained by a questionnaire survey. Multiple regression analysis was used to assess the association between the numbers of nursery users and common infectious diseases before and during the COVID-19 pandemic. The regression coefficient between the number of users of these nurseries and number of common infectious diseases did not change between before and during the COVID-19 pandemic. Many parents may still have wished to use nurseries for children with mild illness during the COVID-19 pandemic.

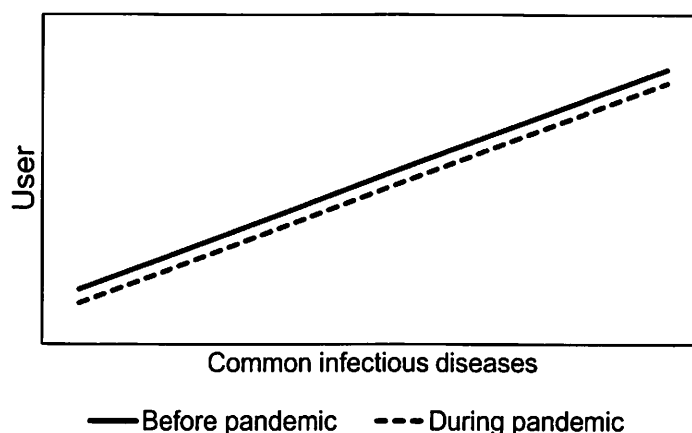
Introduction

Infants and toddlers often suffer from acute illnesses (e.g., infectious diseases) and visit medical institutions twice a month on average¹⁾. However, general daycare centers in Japan do not accept unwell children, even those with mild symptoms, to prevent infectious disease outbreaks²⁾. Therefore, nurseries for children with mild illness have been developed, although most of these are in urban areas^{3,4)}.

During the COVID-19 pandemic, the number of users of nurseries for children with mild illness dropped sharply. A survey conducted by the National Council for Childcare for Sick Children showed the number

of nursery users was 15% in May 2020 compared with the same period in the previous year⁵⁾. Many nurseries for children with mild illness are operated by private medical institutions, and some may be in financial crisis because of this decreased use.

(A) Decrease in the number of common infectious diseases during the COVID-19 pandemic.



(B) Decreased use of nurseries because of fear of a COVID-19 outbreak

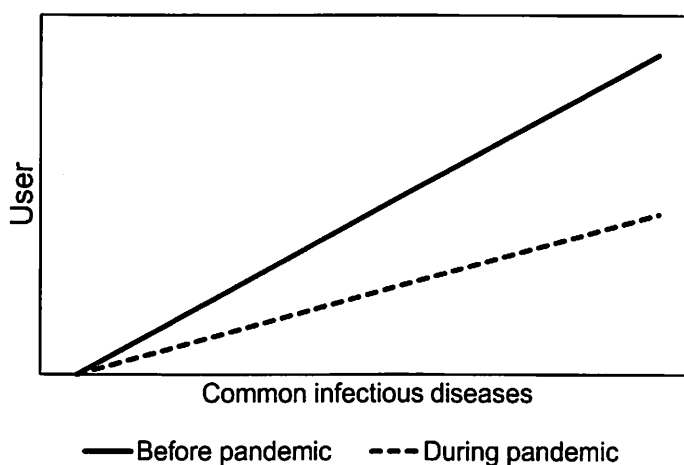


Figure 1. Decrease use of nurseries for children with mild illness during the COVID-19 pandemic. Possible reasons: (A) Decrease in the number of common infectious diseases; (B) Decreased use of nurseries because of fear of a COVID-19 outbreak.

Two possible causes for the decline in use of nurseries for children with mild illness during the COVID-19 pandemic have been proposed. First, efforts to prevent COVID-19 infection (e.g., wearing masks, washing hands more frequently) may have reduced the number of common infectious diseases in children⁶⁾. In addition, if parents worked from home during the COVID-19 pandemic, their children may also have remained at home and had less chance of getting infected. Second, parents may have refrained from using nurseries for children with mild illness as well as out-of-hours pediatric clinics⁷⁾ because they feared a COVID-19 outbreak. The reduced use of

nurseries for children with mild illness may be considered desirable if it was due to a reduction in children with common infectious diseases. Conversely, if parents could not use these nurseries because they feared a COVID-19 outbreak, the child-rearing support function was deteriorated, which is undesirable. However, it is unclear which of these reasons caused the drop in use of nurseries for children with mild illness.

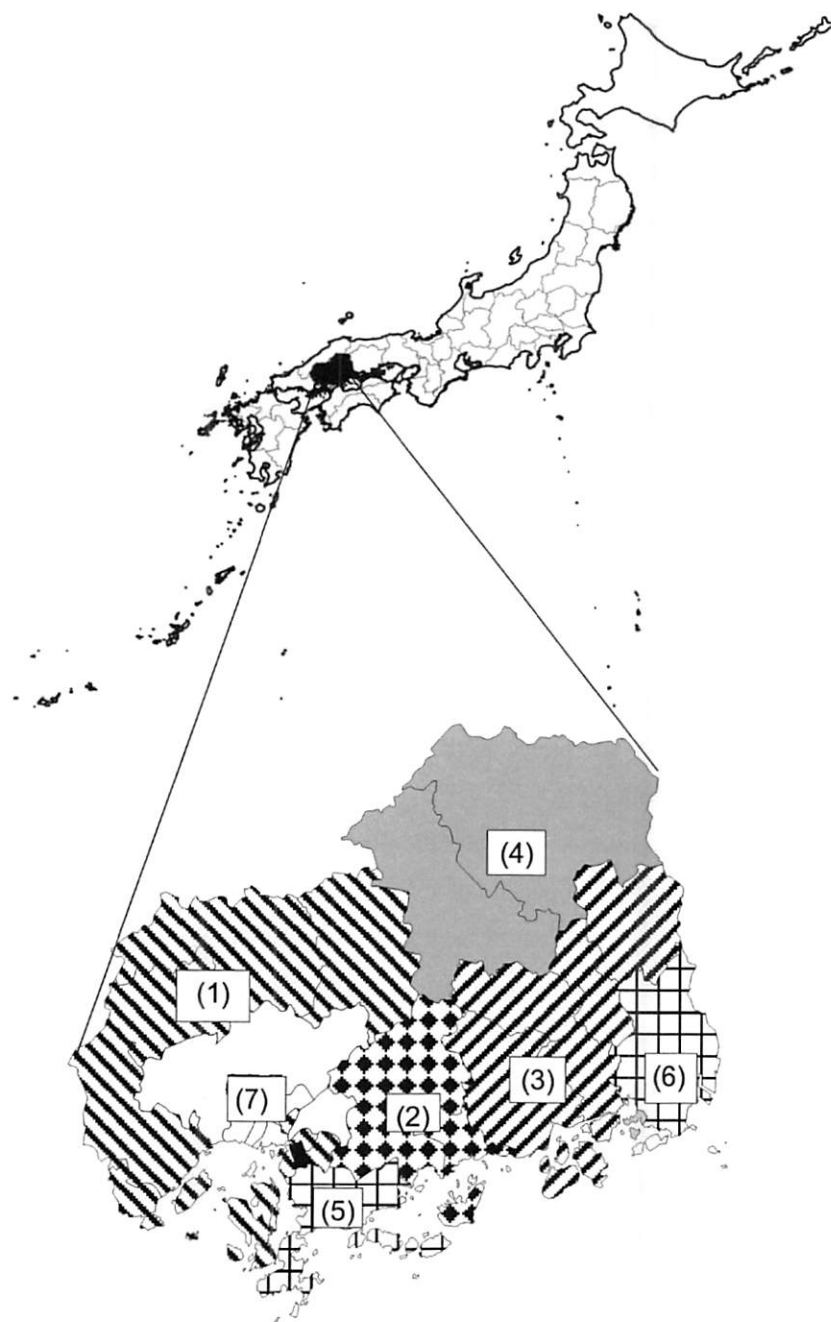
If the decline in nursery use was due to the decreased number of common infectious diseases during the COVID-19 pandemic, the regression coefficient between the number of nursery users and the number of common infectious diseases would be the same before and during the pandemic (Figure 1A). However, if the use of these nurseries was reduced because of fear of a COVID-19 outbreak, the regression coefficient would be lower during the pandemic compared with the pre-pandemic period (Figure 1B). To clarify why the number of users of nurseries for children with mild illness decreased during the COVID-19 pandemic, this study analyzed the relationship between the number of nursery users and the number of common infectious diseases before and during the COVID-19 pandemic.

Material and methods

The target area for this study was Hiroshima Prefecture, one of Japan's 47 prefectures, which has a population of about 2.8 million people ⁸⁾. The prefecture has seven public health centers that conduct weekly surveys of common infectious diseases (Figure 2).

The trends of these infectious diseases are reported to the public health centers by the four types of sentinel medical facilities (pediatric, influenza, ophthalmology, designated sentinel medical facilities; Table 1). Data on the weekly trends in common infectious diseases from January 2018 to March 2021 were provided by the Hiroshima CDC (Center for Disease Control and Prevention). As in the Hiroshima CDC Monthly Report ⁶⁾, the weekly incidence of these diseases was converted to a monthly incidence by adding to results for 4–5 weeks.

Data on the number of monthly users of nurseries for children with mild illness from January 2018 to March 2021 in the 23 municipalities in Hiroshima Prefecture were obtained using a questionnaire survey. The survey form was distributed to the municipalities on April 2, 2021. The survey was resent to cities and towns that did not respond on May 6, 2021, and June 1, 2021. Collected data on the number of children using nurseries for children with mild illnesses were categorized and tabulated for each of the seven health center areas.



(C) Geospatial Information Authority of Japan

Figure 2. Location of Hiroshima Prefecture in Japan and the seven health center areas. Health center areas: 1, West; 2, West East; 3, East; 4, North; 5, Kure City; 6, Fukuyama City; 7, Hiroshima City. Map of Japan reprinted from Global Map Japan (public domain, open-access resources) under a CC BY license, with permission from the Geospatial Information Authority of Japan.

The Day Care Center Infectious Disease Management Guidelines (2018 Revised) ²⁾, specify matters

related to resuming daycare attendance after contracting a common infectious disease (Table 1). These guidelines indicate that most general daycare centers may not accept children with these common infectious diseases. Therefore, it is expected that there would be a strong correlation between the number of the infectious diseases listed in these guidelines and the number of users of nurseries for children with mild illness. Multiple regression analysis was performed to test the relationship between the number of users of these nurseries and the number of sentinel-reported diseases in the seven public health center areas. A dummy variable was used to represent before and during the COVID-19 pandemic.

Table 1. Sentinel-reported diseases and Day Care Center Infectious Disease Control Guidelines, 2018 Revised Edition

Sentinel-reported diseases	Cases in Hiroshima Prefecture in 2019	Listed in the Day Care Center Infectious Disease Control Guidelines, 2018 Revised Edition
Pediatric sentinel-reported diseases	42,780	
Respiratory syncytial virus infection	3,351	YES
Pharyngoconjunctival fever	2,142	YES
Group A streptococcal pharyngitis	6,034	YES
Infectious gastroenteritis	19,581	YES
Chickenpox	784	YES
Hand, foot, and mouth disease	5,914	YES
Erythema infectiosum	1,228	YES
Exanthem subitum	1,231	YES
Herpangina	1,922	YES
Mumps	593	YES
Influenza	37,722	YES
(excl. avian influenza and pandemic influenza)		
Ophthalmology sentinel-reported diseases	660	
Acute hemorrhagic conjunctivitis	12	YES
Epidemic keratoconjunctivitis	648	YES
Designated sentinel-reported diseases (six diseases)	218	YES in 2 diseases

In Hiroshima Prefecture, there were 81,380 sentinel-reported diseases and 786 compulsory notifiable diseases listed in the "Guidelines for Infectious Disease Control in Childcare Centers, 2018 Revision" (as of 2019).

Because of the small number of reports from designated sentinel medical facilities, this study analyzed the number of infectious diseases reported by three types of sentinel medical facilities (pediatric, influenza, and ophthalmology sentinel-reported diseases; Table 1). Pediatric sentinel medical facilities are intended for patients under age 15 years, whereas influenza and ophthalmology sentinel medical facilities are intended for adults and children. Therefore, in the multiple regression analysis with the number of users of nurseries for children with mild illness as the dependent variable, the total numbers of pediatric, influenza, and ophthalmology sentinel-reported diseases were set as separate independent variables. The pandemic dummy variable was set as 0 before March 1, 2020, and 1 thereafter, because most schools in Japan were temporarily closed to prevent COVID-19 as of March 2, 2020⁹⁾. Under the above conditions, the following multiple regression equation was established.

$$y = a_1 * x_1 + a_2 * x_2 + a_3 * x_3 + a_4 * x_4 + (a_5 * x_1 * x_4) + (a_6 * x_2 * x_4) + (a_7 * x_3 * x_4) + b$$

It can also be expressed as:

$$y = (a_1 + a_5 * x_4) * x_1 + (a_2 + a_6 * x_4) * x_2 + (a_3 + a_7 * x_4) * x_3 + (a_4 * x_4 + b)$$

The number of monthly users of nurseries for children with mild illness was indicated by y, and the regression

coefficients by a1–a7 and b. The numbers of monthly cases of pediatric, influenza, and ophthalmology sentinel-reported diseases were indicated by x1–x3, respectively, and the pandemic dummy variable (0 before March 1, 2020, and 1 thereafter) was indicated by x4.

In addition, multiple regression analysis was performed to test the relationship between the number of users of nurseries for children with mild illness and the number of each sentinel-reported disease. All statistical analyses were performed using SPSS version 23.0.0.3 (IBM Corp., Armonk), P-values less than 0.05 were considered statistically significant. As a result of discussions with the Medical Research Ethics Committee for Hiroshima International University, it was determined that this study did not require ethical review (approval number: Rin 20-036, March 22, 2021; Rin 21-020, July 21, 2021).

Results

The questionnaire survey collected data on the number of users of nurseries for children with mild illness for 39 months (January 2018 to March 2021) from all 23 municipalities in Hiroshima Prefecture (recovery rate 100%). The 23 municipalities were divided into the seven health center areas, and the data for users of these nurseries in 273 (39 * 7) month-areas were included in this study.

Figure 3 shows the monthly numbers of pediatric, influenza, and ophthalmology sentinel-reported diseases throughout Hiroshima Prefecture. Influenza epidemics are usually seen from the end of the year to the beginning of the following year but were not evident from the end of 2020 to the beginning of 2021.

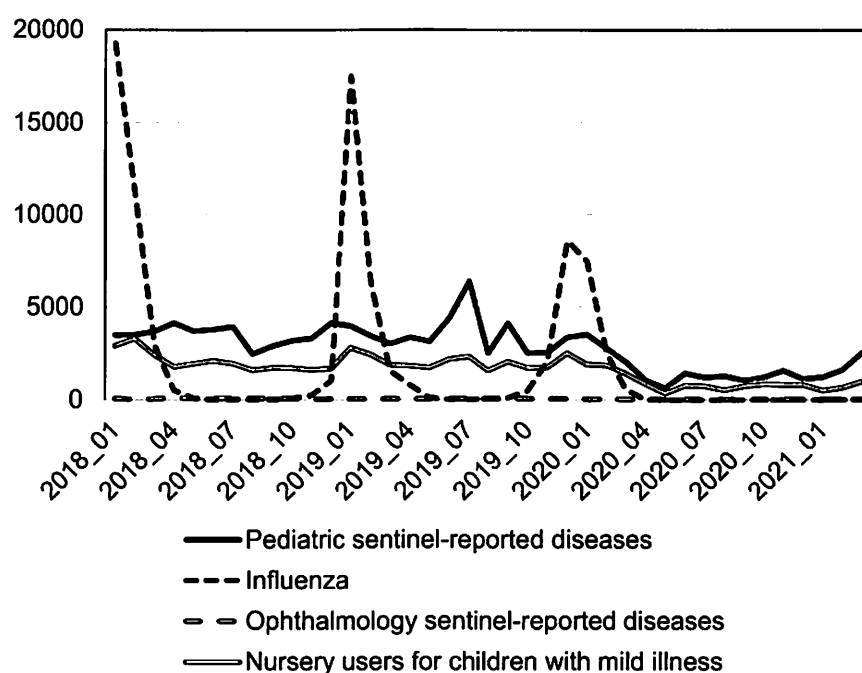


Figure 3. Monthly numbers of pediatric, influenza, and ophthalmology sentinel-reported diseases throughout Hiroshima Prefecture.

Figure 4 shows scatter plots between the number of users of nurseries for children with mild illness and the monthly numbers of pediatric sentinel-reported diseases and influenza.

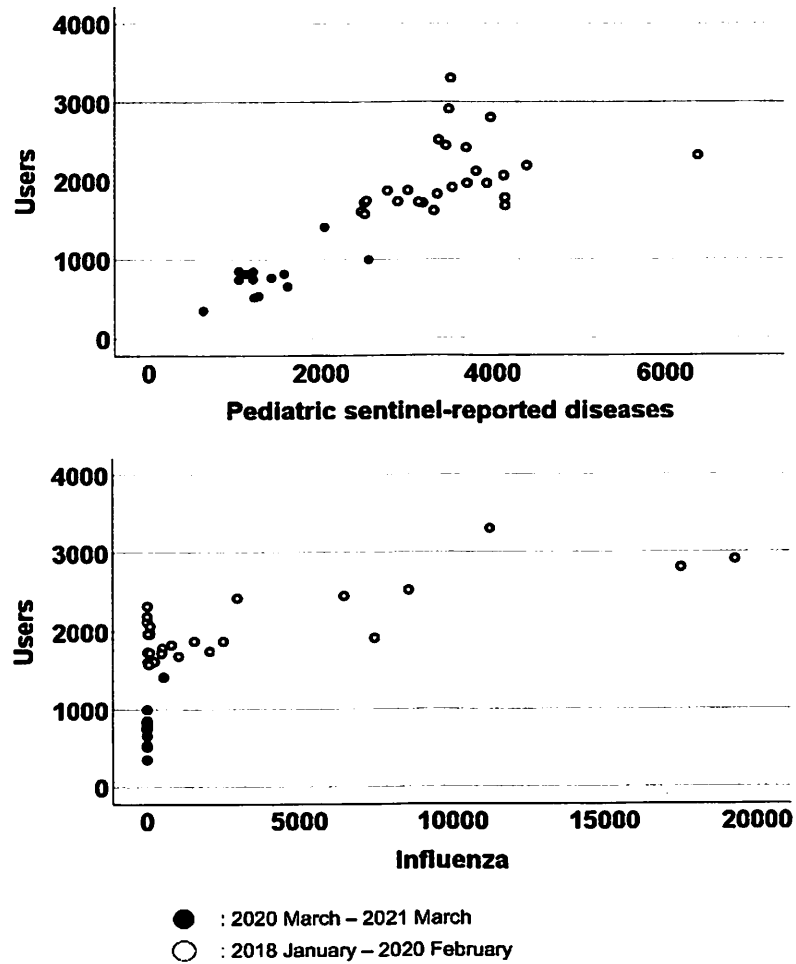


Figure 4. Nursery users for children with mild illness and sentinel-reported diseases (2018 January to 2021 March). Black circles, 2020 March to 2021 March; white circles, 2018 January to 2020 February.

Table 2. Multiple regression analysis of nursery users and sentinel-reported diseases reported diseases.

Independent variable		Non-standardized coefficient				Standardized coefficient	t -value	P-value
		Estimated	Standard deviation	95% Confidence interval				
				Lower	Upper			
Pediatric sentinel-reported diseases (x_1)	a_1	0.909	0.050	0.811	1.007	0.837	18.202	<0.001
Influenza (x_2)	a_2	0.113	0.014	0.086	0.141	0.242	8.111	<0.001
Ophthalmology sentinel-reported diseases (x_3)	a_3	1.465	1.556	-1.599	4.529	0.040	0.941	0.347
Pandemic dummy (0, before March 1, 2020; 1, thereafter; x_4)	a_4	179.988	37.189	106.765	253.212	0.231	4.840	<0.001
Coefficient	b	-228.126	21.702	-270.856	-185.395		-10.512	<0.001
Pediatric sentinel-reported diseases (x_1) × Pandemic dummy (x_4)	a_5	-0.184	0.157	-0.493	0.125	-0.063	-1.171	0.243
Influenza (x_2) × Pandemic dummy (x_4)	a_6	0.220	0.632	-1.024	1.464	0.011	0.348	0.728
Ophthalmology sentinel-reported diseases (x_3) × Pandemic dummy (x_4)	a_7	2.607	5.336	-7.899	13.113	0.020	0.489	0.626

Dependent variable (y): monthly number of users of nurseries for children with mild illness
 $y = (a_1 + a_5 * x_4) * x_1 + (a_2 + a_6 * x_4) * x_2 + (a_3 + a_7 * x_4) * x_3 + (a_4 * x_4 + b)$
 x_1 - x_3 : numbers of monthly cases of pediatric, influenza, and ophthalmology sentinel-reported diseases
 x_4 : pandemic dummy variable (0 before March 1, 2020, and 1 thereafter)
 Adjusted coefficient of determination: 0.791

Table 2 shows the results of the multiple regression analysis between the number of monthly users of nurseries for children with mild illness and the monthly numbers of pediatric, influenza, and ophthalmology sentinel-reported diseases reported diseases. The adjusted coefficient of determination by multiple regression analysis was 0.791. The regression coefficients for the number of pediatric sentinel-reported diseases and influenza were significantly above 0 ($P < 0.001$), but this was not the case for ophthalmology sentinel-reported diseases ($P = 0.347$). The coefficient for the pandemic dummy variable (0 before March 1, 2020, and 1 thereafter) was also significantly above 0 ($P < 0.001$). However, the product of the pandemic dummy variable multiplied by the numbers of pediatric, influenza, and ophthalmology sentinel-reported diseases did not have coefficients significantly different from 0 ($P = 0.243, 0.728, \text{ and } 0.626$, respectively).

Table 3 shows the results of the multiple regression analysis between the number of monthly users of nurseries for children with mild illness and the number of each sentinel-reported disease. The adjusted coefficient of determination by multiple regression analysis was 0.849. All sentinel-reported diseases had coefficients significantly above 0, except for pharyngoconjunctival fever, herpangina, mumps, and epidemic keratoconjunctivitis.

Table 3. Multiple regression analysis of nursery users and each sentinel-reported disease

Independent variable	Non-standardized coefficient				Standardized coefficient	t-value	P-value
	Estimated	Standard deviation	95% Confidence interval Lower	95% Confidence interval Upper			
Pediatric sentinel-reported diseases							
Respiratory syncytial virus infection	1.074	0.244	0.594	1.555	0.128	4.402	<0.001
Pharyngoconjunctival fever	-1.352	0.563	-2.461	-0.244	-0.071	-2.404	0.017
Group A streptococcal pharyngitis	1.457	0.296	0.875	2.040	0.261	4.930	<0.001
Infectious gastroenteritis	0.592	0.090	0.415	0.769	0.291	6.589	<0.001
Chickenpox	4.993	1.426	2.185	7.800	0.126	3.502	0.001
Hand, foot, and mouth disease	0.396	0.153	0.095	0.697	0.106	2.594	0.010
Erythema infectiosum	5.577	1.053	3.504	7.650	0.166	5.297	<0.001
Exanthem subitum	2.736	1.313	0.150	5.322	0.078	2.083	0.038
Herpangina	0.455	0.456	-0.443	1.352	0.040	0.998	0.319
Mumps	2.227	1.805	-1.327	5.780	0.036	1.234	0.218
Influenza	0.088	0.014	0.061	0.115	0.187	6.372	<0.001
Ophthalmology sentinel-reported diseases							
Acute hemorrhagic conjunctivitis	72.191	15.732	41.211	103.171	0.130	4.589	<0.001
Epidemic keratoconjunctivitis	-0.826	1.507	-3.793	2.142	-0.022	-0.548	0.584
Pandemic dummy (0, before March 1, 2020; 1, thereafter)	126.497	24.771	77.719	175.276	0.162	5.107	<0.001
Coefficient	-207.571	21.121	-249.162	-165.980		-9.828	<0.001

Dependent variable: monthly number of users of nurseries for children with mild illness.

Adjusted coefficient of determination: 0.849.

Discussion

The present analysis of the use of nurseries for children with mild illness in Hiroshima Prefecture confirmed that the number of nursery users dropped sharply during the COVID-19 pandemic. However, no significant interaction was observed between the number of reported cases of common infectious diseases and the pandemic dummy variable in the multivariate regression analysis. The regression coefficients for the number of nursery users and the number of common infectious diseases during the COVID-19 pandemic were unchanged from before the pandemic (Figure 1A), except for an increase in the intercept ($a_4 * x_4 + b$; Table 2) during the pandemic. It is therefore likely that the use of nurseries for children with mild illness may have decreased during the COVID-19 pandemic because the number of common infectious diseases decreased, rather than because parents refrained from using nurseries for these children. With a few exceptions, the number of each type of infectious disease was also positively associated with the number of users of nurseries for children with mild illness.

During the COVID-19 pandemic, the proportion and absolute number of patients with mild illnesses who visited after-hours clinics in Hiroshima, Japan decreased ⁷⁾. However, coverage of vaccinations against common infectious diseases did not change significantly between before and during the pandemic ¹⁰⁾. Similarly, the demand for daycare for children with mild illness may not have changed significantly between before and during the pandemic. The reasons for this are unknown. However, it has been reported that the telecommuting rate outside the three major metropolitan areas in Japan (Tokyo, Kinki, and Chukyo) during the pandemic was only 12% ¹¹⁾. Therefore, the childcare support environment for children with mild illness in Hiroshima Prefecture may not have changed significantly between before and during the pandemic.

I found a significant positive correlation between the pandemic dummy variable (0 before March 1,

2020, and 1 thereafter) and the number of users of nurseries for children with mild illness. The intercept of the regression line was larger during the COVID-19 pandemic than before the pandemic. The reason for this finding is unknown. Before the pandemic, these nurseries may have not accepted more children with mild illnesses than their capacity because of the large number of applicants who wanted to use them. However, during the pandemic, the small number of users suggests that most children up to the capacity could have used these nurseries. This may have led to an increase in the intercept of the regression equation. Although the central government requested that prefectures considered reducing the provisional capacity for childcare to prevent outbreaks of COVID-19 on April 7, 2020 ¹²⁾, the decrease in nursery users appeared to have been greater than this reduction ⁵⁾. Therefore, it is probable that most children were able to use these nurseries during the pandemic.

Most nurseries for children with mild illness are not profitable despite being privately owned ¹³⁾. Therefore, a decrease in the number of nursery users may lead to these facilities ceasing to operate. Children often suffer from acute illnesses such as infectious diseases ¹⁾, meaning that they cannot attend a general daycare center. A survey conducted by the National Diet Library of Japan ¹⁴⁾ found no data on daycare services for children with minor illnesses in other countries as it is standard practice to provide care at home for children when they become ill. However, many parents in Japan do not take paid leave when their children are acutely ill because of peer pressure not to burden their colleagues by taking leave ^{15,16)}. Improving Japan's work culture is an important step, but this will take time. Therefore, it is necessary to create a child-rearing support environment that can be used by both healthy children and those with mild illnesses. To create such an environment, it will be necessary to invest more public funds.

Limitations

- 1) The severity of reported cases of infectious diseases was unknown. In addition, it was also unknown how many days these nurseries were used after such illness.
- 2) The age distribution of each sentinel-reported disease was unknown, and therefore may or may not have matched the age range for childcare.
- 3) The employment status of parents and the availability of alternative caregivers (e.g., family members and friends) were unknown.

However, about 80% of the number of users of nurseries for children with mild illness can be explained by the number of reported cases of infectious diseases (adjusted coefficient of determination about 0.8). Therefore, it is likely that most of these nursery users can be explained by the number of sentinel-reporting diseases.

Conclusions

The decrease in the number of children with mild illness using nurseries during the COVID-19 pandemic may be related to the decrease in common infectious diseases, rather than to parents refraining from using nurseries because they feared a COVID-19 outbreak. Many parents may have wished to continue to use nurseries for children with a mild illness even during the COVID-19 pandemic.

Acknowledgement

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和文抄録

COVID-19 のパンデミックの際には病児対応型保育施設の利用者数が激減した。本研究では、その理由を明らかにすることを目的として、2018年1月から2021年3月までの間に広島県内7保健所に報告された一般的な感染症の発生数と同期間の広島県23市町村の病児保育施設の月間利用者数との重回帰分析を行った。この結果、COVID-19パンデミックの前と中では、病児対応型保育施設の利用者数と一般的な感染症発生数との間の回帰係数に大きな変化はなかった。