Original Article

Association among (Nursery) School Absenteeism Surveillance System and Incidence of Infectious Diseases

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[Received April 5, 2017 ; Accepted April 4, 2018]

Background: We introduced a (Nursery) School Absenteeism Surveillance System ((N)SASSy) in 2009, which recorded information related to students who were absent from nursery schools and schools because of disease infection. As of the end of March, 2010, was activated it at the all schools in those prefectures. It expanded to include another 8 prefectures in the following two years.

Objective: We evaluated this system using a nationwide database (National Database of Electronic Medical Claims (NDBEMC)) that includes 96.2% of all medical claims from medical institutions in Japan.

Methods: To evaluate association among (N)SASSy and incidence, we regressed the number of disease patients on whether (N)SASSy was used in those prefectures or not and other control variables. We examined common pediatric infectious diseases: influenza; varicella; respiratory syncytial virus infection (RS); hand, foot and mouth disease (HFMD); mycoplasma pneumonia (MP); aseptic meningitis (AM); erythema infectiosum (EI); exanthem subitum (ES); and herpangina.

Results: Significant effects of (N)SASSy were found on the prevalence of influenza, varicella, HFMD, MP, AM, and herpangina. When (N)SASSy started, the number of patients with these diseases declined by 53, 20, 192, 89, 73, and 38% in comparison with their respective averages.

Conclusion: We proved that negative association among (N)SASSy and the incidence of some infectious diseases. Moreover, association seems to be strong.

Keywords: school absenteeism, infectious diseases, nursery school, national database, electronic medical claims

[School Health Vol.14, 21-27, 2018]

I. Introduction

We introduced the (Nursery) School Absenteeism Surveillance System ((N)SASSy)[1,2] in Japan in 2009. It has been operated by the Japanese Society of School Health, recording information related to students who are absent from (nursery) school because of infectious diseases. The term “school” used in this paper means any educational institution in Japan, including kindergartens with 4 to 5-year-old students, elementary schools with 6 to 12-year-olds, junior high schools with 13 to 15-year-olds, and high schools with 16 to 18-year-olds. Only elementary schools and junior high schools are compulsory education. However, some children younger than five years old attend nursery schools, which are welfare facilities (equivalent to “day care” in many nations) and not educational institutions. Therefore, we discriminate nursery schools from “schools.” The term of (nursery) school in this paper includes both nursery schools and “schools.”

As of the end of 2014, the system covered approximately 22,000 schools, which collectively account for about half of all schools in Japan. It also covers approximately 8,000 nursery schools, which collectively account for about one-third of all nursery schools nationwide. In total, it monitors the health condition of about 6 million children, who are younger than 18 years old, every day.

(N)SASSy records the numbers of patients with infectious diseases and shows information in real-time. Therefore, (N)SASSy is useful for teachers and/or the persons concerned, such as officers in public health centers and local governments, to prevent spread of infectious diseases.

This system has been evaluated qualitatively and non-statistically to utilize for the control of outbreaks in (nursery) schools[1) 2)]. It has not been evaluated rigorously or statistically to date because (N)SASSy cannot provide an equivalent quality of information for areas without (N)SASSy. This problem is commonly encountered in program evaluation. To avoid this difficulty posed by unobserved data, we use a dataset other than (N)SASSy, which encompasses the whole of Japan, which is used nationwide and which is comparably precise and reliable to (N)SASSy.

Another potential candidate for nationwide and precise surveillance is the National Database of Electronic Medical Claims (NDBEMC). It includes all electronic medical claims nationwide, which are provided by the Ministry of Health, Labour and Welfare in Japan (MHLW) as "Data of Medical Claims and Health Check-Ups for Metabolic Syndrome"[3–6)], covering 96.2% of all medical claims from medical institutions in Japan as of October, 2013[7)]. Because the data include diagnosis information, therefore, it is apparently the most reliable data source for the number of patients of diseases in Japan. We use it as a benchmark to evaluate (N)SASSy.

In this study, we aimed to evaluate the effect of on the number of patients with infectious diseases (N)SASSy. It might be considered other effects influence to the number of patients, for example, population density, or, age distribution in each prefecture. So as to resolve it, we regressed the number of patients with each disease on the dummy variable for whether (N)SASSy was operated or not with other control variables including fixed for prefectures.

II. Materials and Methods

1. (N)SASSy

(N)SASSy, a real-time surveillance system, was designed to collect information related to school absenteeism and symptoms caused by infectious diseases. Officers in public health centers, local governments, medical associations, educational boards (boards overseeing local public schools), and school physicians can review all the information made available only to these groups soon after information is provided by schools. Information related to school absenteeism and symptoms associated with absenteeism is entered online every weekday. (N)SASSy shares information automatically with public health professionals at the local, prefectural, and national levels in Japan.

(N)SASSy includes symptoms of absenteeism by class including fever, headache, respiratory symptoms, diarrhea, vomiting, rash, influenza-like illness (ILI, it was defined as shown all the following symptoms: acute onset, high fever >38°C, upper respiratory symptoms, systemic symptoms including fatigue, or positive results from an influenza rapid diagnosis kit.), and others, based on reports from caregivers every morning. If caregivers report multiple symptoms, then (N)SASSy records all the corresponding symptoms, except for ILI. In the case of ILI, it requires no record of fever or respiratory symptoms. Moreover, except for nursery schools, according to the School Health and Safety Act, when students are diagnosed with defined infectious diseases, schools should not allow students to attend classes. To conform to that policy, caregivers must quickly report a doctor's diagnosis for their children. For every weekday in all schools and classes, (N)SASSy records and reports the number of children suspended for infectious diseases. Suspension for infectious diseases is unique to the Japanese national system.

Nursery schools cannot keep their children from attending school. However, children with infectious diseases are usually absent from nursery school voluntarily. Their caregivers usually report the symptoms and nature of infection to the nursery school. Therefore, (N)SASSy precisely records and reports the number of patients with varicella.

If some children in a nursery school show some symptoms, then (N)SASSy records them. The nursery school asks their caregivers to pick them up as soon as possible, but sometimes caregivers cannot come to the nursery school quickly. However, even if some students show symptoms at their schools, (N)SASSy does not record them because they usually return home, in principle.

Jurisdiction for (nursery) schools is divided among prefectures. Operations of (N)SASSy are not the same among prefectures. The decision to activate the system or not, and the starting season of (N)SASSy have differed among prefectures. After its inception in 2009 in 10 prefectures (Tottori, Gifu, Shimane, Kagawa, Niigata, Ibaraki, Saga, Chiba, Miyagi, and Nagasaki), (N)SASSy had come to be used in all schools in those prefectures by 2010, but not in all nursery schools. In 2011 and 2012, it expanded to include another 8 prefectures (Nagano, Oita, Kochi, Akita, Kagoshima, Mie, Nara, and Gunma). We note that the starting season of (N) SASSy differs prefecture by prefecture. Moreover, (N) SASSy for all nursery schools had been activated in only four prefectures: Ibaraki, Gunma, Nara, and Mie. In the other 14 prefectures, (N)SASSy for all schools had been operated. However, data do not include all nursery schools. All school in those prefectures had started to use (N)SASSy at the same time in 2009, 2011 or 2012.

2. NDBEMC

Our used NDBEMC data include the numbers of patients by month. We used the reported number of patients who had been diagnosed as having each common pediatric infectious disease, excluding suspected cases, including complex cases, by month[8].

It has no information related to age. Therefore, we defined the number of patients of all ages with those diseases. We used NDBEMC data from April 2010 to March 2013.

3. Targeting Diseases and Study Periods

We considered common pediatric infectious diseases such as influenza; varicella; RS (respiratory syncytial) virus infection (RS); hand, foot; and mouth disease (HFMD); mycoplasma pneumonia (MP); aseptic meningitis (AM); erythema infectiosum (EI); exanthem subitum (ES); and herpangina.

We defined three seasons as those during April–March of the subsequent year. Alternatively, we used another definition of season for influenza, i.e. during September–August of the subsequent year, which is commonly used in epidemiological studies. In this case, the last year ended March 2013.

4. Statistical procedures

To evaluate the association of (N)SASSy use and incidence, we regressed the number of patients with *i*th diseases in *t* season in prefectures *j*, N_{ijt}, on the dummy variable for whether (N)SASSy was operated or not (S_{jt}) with other control variables such as

$$N_{ijt}=\alpha_i+\beta_i S_{jt}+\gamma_i P_{jt}+\sum_{k=2}^{47}\delta_{ik}A_k+\sum_{l=2011}^{2012}\eta_{il}Y_l+\varepsilon_{ijt} \tag{1}$$
$$(i=1,2,\cdots 9),\ (j=1,2,\cdots 47),\ (t=2010,2011,2012)$$

using weighted least squares weighted by the number of population P_{jt} with dummy variables for prefecture j, A_j, and season dummy Y_l. k (l) is the subscription for prefecture (year) of summation in the fourth (fifth) term in the right hand side of equation, and it varied two (2011) to 47(2012). The reference of A_j and Y_l are Hokkaido and 2010 season. In this equation, δ describes the fixed for prefecture, which reflects intrinsic difference among prefectures. We adopted 5% as the level of significance. In this estimation, if the estimated βi was significantly negative, it means negative association among (N)SASSy and the prevalence of disease i.

5. Ethics

(N)SASSy collects the number of patients reported to have each disease, with no personal information such as a name or address. Therefore, these are anonymous data. The numbers of patients from NDBEMC were also aggregated and unlinked from personal information. Therefore, this study is not apply to "Ethical Guidelines for Medical and Health Research Involving Human Subjects", which approved by the National Institute of Infectious Diseases committee for ethical consideration, no ethical issue exists in relation to the use of these data for this study.

III. Results

Table 1 presents summary statistics for each disease over three seasons by all 47 prefectures per one season. The total number of samples was 141. The mean number of patients with influenza, approximately 170 thousand, was the largest number in the target diseases. The fewest patients were those with aseptic meningitis, approximately 60.

Table 2 presents the estimated βi, its p-values, 95% confidence interval, and adjusted R^2. Because the adjusted R^2 values were quite high except for HFMD, the estimation model fit the data well. Regarding HFMD, geographical and temporal variation are well known to be high. Its goodness of fit was the worst among those for the considered diseases.

Table 1 Summary Statistics for the Considered Diseases

Diseases	Mean	Std. Dev.	Min	Max
Influenza	169614.60	167589.30	34780	953397
Varicella	18332.62	16655.20	3953	81356
RS virus infection	2971.37	2969.65	598	18250
Hand, foot and mouth disease	7680.15	12407.61	15	72375
Mycoplasma pneumonia	5948.33	6894.39	498	46104
Aseptic meningitis	61.60	64.63	8	371
Erythema infectiosum	3183.61	4096.11	65	22255
Exanthem subitum	2649.90	2718.24	590	14300
Herpangina	4660.62	5648.76	443	34803

(persons)

Table 2 Estimation Result for 1 (N)SASSy dummies

Diseases	Estimated Coefficients	*p*-value	95% C.I.		Adjusted R^2
			Lower	Upper	
Influenza	-90735.29	.001	-143319.30	-38151.24	.9742
Influenza *	-84750.59	.004	-141127.80	-28373.42	.9710
Varicella	-3750.46	.013	-6677.11	-823.81	.9911
RS virus infection	1278.97	.074	-127.15	2685.09	.9455
Hand, foot and mouth disease	-14795.38	.017	-26865.51	-2725.24	.7835
Mycoplasma pneumonia	-5277.62	.005	-8904.51	-1650.73	.9404
Aseptic meningitis	-44.92	.001	-70.38	-19.46	.9615
Erythema infectiosum	-542.75	.769	-4197.18	3111.68	.8035
Exanthem subitum	-220.55	.060	-450.86	9.76	.9982
Herpangina	-1780.25	.036	-3438.52	-121.98	.9816

Notes: This table presents estimation results of (N)SASSy dummy obtained using weighted least squares method weighted by population of the prefecture each year. The estimated equation included the number of population, the dummy variables for prefectures, and the dummy variables for season as explanatory variables. * denotes estimation results for the case in which that the season is defined as September−August.

We found significant associations of (N)SASSy on the decline in the prevalence of influenza, varicella, HFMD, MP, AM, and herpangina. In other words, when (N)SASSy started,the number of patients with these diseases were declined by 53, 20, 192, 89, 73, and 38% in comparison with the respective averages in Table 1. If the season is defined as September–August for influenza, then the estimated coefficients became smaller, but they are still significant and negative. Conversely, for RS, EI, or ES, it has not caused a decrease.

IV. Discussion

There are many surveillance systems of school absenteeism in the world. Those focused to find on the relationship among school absenteeism and incidence of infectious disease, mainly influenza[9-14]. On the other hand, this paper examined how the introduction of school absenteeism surveillance affect the incidence of infectious diseases. This is the first to show association among surveillance of school absenteeism and the incidence of infectious diseases.

We used NDBEMC to evaluate the number of patients from (N)SASSy. On the other hand, another candidate for such a nationwide and precise surveillance is Official National Surveillance for Infectious Diseases. It monitors common infectious diseases, especially pediatric diseases, at sentinel medical institutions in Japan based on the Law Concerning the Prevention of Infectious Diseases and Medical Care for Patients of Infections (Infectious Diseases Control Law). The numbers of cases were reported from only 3,000 sentinel medical institutions, which collectively account for only about one-tenth of all pediatric medical institutions nationwide for pediatric common infectious diseases. For influenza, 5,000 sentinels including internal medical institutions have been reporting data. However, because no estimate of the total number of patients has been published, we cannot use this information to evaluate (N)SASSy.

We proved that the negative association between using of (N)SASSy and the incidence of some infectious diseases. Moreover, its relationship is apparently strong. It may imply that using of (N)SASSy may decrease the number of patients of the considered infectious disease. However, we note that such an association may not mean some causality. Namely, other factor, such as epidemiology of the disease or prevalence of vaccination for example, affect incidence and casually the other factor show the similar pattern of prevalence of (N)SASSy. We need more data, especially expansion of (N)SASSy to control such an confounder so as to solve the causality.

On the other hand, some diseases, especially those which are common for children younger than five years old, such as RS, EI, or ES, might not be affected, perhaps because (N)SASSy has not covered nursery schools yet in many prefectures. There, it covers only elementary, junior high, and high schools. These three diseases appear to affect mainly younger children. They are rare in schools for older children.

The ratio of the estimated coefficients for HFMD over its average number of patients for HFMD was greater than 100%, which may imply that the use of (N) SASSy can eliminate the disease in a prefecture. This result seems obviously strange. As it is well known, the epidemic patterns of HFMD are quite different season by season and area by area. This somewhat strange estimation result may implies that the used data is not sufficient to analyze for HFMD. Or the adopted linear regression may be miss-specified for HFMD. In both case, data accumulation in next few seasons may solve this phenomena. This reminds as future works.

We demonstrated that negative association among (N)SASSy and incidence of some infectious diseases. Nevertheless, some diseases such as mumps were excluded from analyses because of limitations of our application to NDBEMC. We must include these excluded diseases when submitting an application for NDBEMC next time.

As described above, (N)SASSy records and shares information related to infectious diseases among teachers, caregivers, and schoolchildren. Especially, school nurses (yogo teachers) can access all information obtained for the located prefecture. Moreover, the information is shared among public health centers and physicians. This information is apparently beneficial directly not only for early detection and response, but also for preventive behavior and as a reminder. These direct and indirect effects of (N)SASSy are expected to exert a strong effect on the incidence of infectious diseases.

In this estimation, this formulation seems to be more flexible for population size comparison with the case in which incidence rate, N_{ijt}/P, is dependent variable or γ is fixed as 1. We prefer more flexible formulation so as to be more precise prediction. Actually, the null hypothesis $\gamma=1$ were rejected in the considered diseases except for influenza and varicella (not shown).

However, it is not unclear which effect, direct or indirect, is the most powerful. We infer that growing awareness of infectious diseases by teachers, caregivers, and students, induces some preventive behavior, probably constituting the most powerful effect of reducing incidence. More precise analyses might elucidate the effects to a greater degree. Moreover, the study period, which covers only three seasons, might not be sufficiently long. In addition, the data of NDBEMC had been aggregated in all ages. The information of age in patients was important especially for influenza or varicella, Therefore, we must continue to evaluate the impact of (N)SASSy, especially for diseases excluded from analyses in this study.

V. Conclusion

Results show strong negative association among (N)SASSy and incidence of some infectious diseases. Though the causality has not proven in this paper yet. it remind as the next challenge. (N)SASSy must be expanded to include another 23 prefectures to cover the entirety of Japan by 2020, the year of the Tokyo Olympics and Paralympics so as to control infectious disease and detect outbreak during the games.

VI. Acknowledgments

We acknowledge the approximately 30,000 participating nursery schools, kindergartens, and schools using (N)SASSy, and the Japanese Society of School Health, which operates (N)SASSy. This study was supported by MEXT KAKENHI Grant Number 15K01676.

VII. Conflict of interest

The authors have no conflict of interest to declare.

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