Glycative Stress Research

Online edition : ISSN 2188-3610
Print edition : ISSN 2188-3602
Received : April 1, 2023
Accepted : May 8, 2023
Published online : June 30, 2023
doi:10.24659/gsr.10.2_64

Original article

The influence of the type of rice served at school lunches on COVID-19 infection in kindergartens and nursery schools

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Abstract

***Purpose*:** The purpose of this study was to investigate the effect of processed brown rice on COVID-19 infections by examining whether the number of COVID-19 cases in preschools in 2021 differed depending on whether one type of processed brown rice (sub-aleurone layer residual rinse-free rice: SARFR), or white polished rice, was used as the source of the cases. This study aimed to investigate the effect of processed brown rice on COVID-19 infections.

***Methods*:** We investigated the number of COVID-19 cases among preschool infants from April 2021 to March 2022 in kindergartens and nursery schools whose nutritional value of facilities was calculated based on the Dietary Reference Intakes for Japanese by the Ministry of Health, Labor and Welfare. The survey was conducted in the same area within a 3-km linear distance radius, followed by additional surveys of preschools in neighboring areas within a 10-km linear distance radius. Furthermore, we compared the COVID-19 incidence rate with that of Tokyo, where the participating preschools are located.

***Results*:** Among preschool infants in the same area, those who received processed brown rice for lunch had a significantly lower percentage of COVID-19 cases than those who received white polished rice. In the neighboring areas, the proportion of affected individuals was also significantly lower in the group consuming processed brown rice. Furthermore, compared to the incidence rate in Tokyo, the incidence rate in the kindergartens where the processed brown rice was consumed tended to be lower.

***Conclusion*:** There was a trend toward a lower proportion of COVID-19 infections affected by preschool infants consuming processed brown rice. In the future, it is necessary to examine the preventive effect of consuming processed brown rice not only on COVID-19 but also on other infectious diseases, as well as its mechanism.

***KEY WORDS*:** sub-aleurone-remaining wash-free rice (SARWR), processed brown rice, COVID-19, infant

Introduction

Brown rice is thought to be rich in functional components that are expected to have disease-preventive effects, and the effects of each component have been studied [1,2]. In particular, phytic acid [3,4] and ferulic acid [5,6] are reported to have anti-inflammatory and antioxidant effects, and lipopolysaccharides (LPS) have immunostimulatory effects [7-9]. Practically, more than 300 people have been reported to improve their health and reduce their morbidity due to the consumption of processed brown rice [10]. These studies suggest that consumption of brown rice may be useful in preventing infectious diseases and avoiding the more serious states when infection does occur. However, there have been no large-scale studies in Japan on the relationship between rice and infectious diseases in preschool infants.

COVID-19, which became a global pandemic in December 2019, initially caused few severe cases in children [11,12]. In December 2021, a large-scale outbreak of the mutant Omicron strain occurred, and the number of infected children has been increasing, indicating that severe cases of COVID-19 are occurring [13]. The number of infected children has been increasing, and severe cases have been reported [14]. In light of this, an indication for the vaccination of child with the novel coronavirus vaccine was highlighted. However, even now, there is no overall agreement on whether or not children should be vaccinated [15,16]. In particular, there are no clear standards for vaccination of infants.

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COVID-19 infection brought about numerous changes to our daily lives. Consequently, there have been changes in the health status of children, with weight gain and decreased exercise time reported compared to pre-COVID-19 epidemic levels [17,18]. One of the causes of weight gain was noted to be an increase in dietary intake of confectionery, sugary drinks, and instant foods [19], pointing to the possibility that disordered eating may have a significant impact on children's health [17-19]. One possible effect of the increase in infectious diseases is the disruption of diet due to prolonged COVID-19 infection. These results call for the need to investigate the possibility of preventing infectious diseases and avoiding their severity through diet, especially in preschool infants, for whom it is difficult to determine whether or not to take a vaccine.

Therefore, as a preliminarily study, this study focused on the impact of rice consumption differences on the number of COVID-19 cases among preschool infants in the year 2021 stored in each kindergarten and nursery school on infectious diseases. All participating preschools were included only those that calculated the nutritional value of their facilities based on the Dietary Reference Intakes for Japanese by the Ministry of Health, Labor and Welfare. The participants were preschool infants who did not have any chronic illnesses, disabilities, or diseases. We then investigated whether there was a difference in the number of COVID-19 cases depending on whether the rice was sub-aleurone layer residual rinse-free rice (SARFR) or white polished rice (WPR). This study focused on SARFR, a type of processed brown rice that is easier to eat and more digestible [20,21]. SARFR is a rice with a residual sub-aleurone layer that contains many of the nutritional and flavor components of brown rice. Oral consumption of the sub-aleurone layer has been shown to improve constipation, susceptibility to colds, and skin complaints by subjective evaluation, indicating that it may be a functional food [22]. There are reports at academic meetings on immune function activation by SARFR intake [23,24]. The current study investigated the impact of SARFR on COVID-19 morbidity in preschool infants.

Method

Subjects

Children in kindergartens and nursery schools in Koto-ku, Tokyo, where the nutritional value of the facilities was calculated based on the Dietary Reference Intakes for Japanese by the Ministry of Health, Labour and Welfare, were included in the study. Two kindergartens, one of which consumed SARFR and the other consumed WPR, were within 3 km of each other. To avoid obtaining personal information, we obtained data on the number of infants affected by COVID-19 as reported by the preschools to the national and local governments. We excluded infants who had any of the following conditions: 1) infants who consumed less than 80 % of school lunch per year, 2) infants with pre-existing medical conditions such as childhood diseases, 3) infants with physical disabilities such as physical diseases, 4) infants with developmental disabilities, or 5) infants with other problems in their home environment, which may be background factors. We excluded preschoolers whose living environment may differ significantly from that of other preschoolers.

Data were obtained for 440 infants in the preschools with SARFR intake and 109 infants in the preschools with WPR intake. In addition, due to the small number of WPR ingesting preschoolers, an additional survey was conducted within a 10-km linear distance from the two preschools. At a preschool in Urayasu City, Chiba, 131 infants who did not comply with the exclusion criteria were added. Because we only obtained the number of infants, we did not obtain data on the ages of the infants, but only those aged 3 to 5 years, and we did not obtain any personal information, *i.e.*, gender ratios.

SARFR (sub-aleurone layer residual rinse-free rice)

SARFR is rice that has been polished to remove the rice bran layer from the rice husk, leaving the sub-aleurone layer, the base of the germ (golden bud), the blastocoel, and the endosperm. The sub-aleurone layer contains many of the nutrients of brown rice and has a sweet taste that makes it desirable. It has already been reported that it contains more B vitamins and dietary fiber than WPR, as well as more carbohydrates that affect the environment in the gastrointestinal tract [21].

Survey Methodology.

Recruitment was conducted for preschools to which Meal Care Corporation (Nagano, Japan) distributes school lunches. One kindergarten in Koto-ku, Tokyo, that consumes SARFR announced its participation (Preschool A). Preschool A enrolled infants aged 3 to 5 years old. With a referral from Preschool A, recruitment was conducted to Preschool B, which consumes WPR in the same area (Koto-ku). The preschool B also had infants aged 3 to 5 years old. The distance between Preschool A and Preschool B was within 3 km. From the data on the number of infants affected by COVID-19 reported by the preschools to the national and local governments, the person in charge in each preschool calculated the number of infants excluding those who violated the exclusion criteria. As a result, Preschool A had a large number of infants and was able to obtain information on 440 attendees who did not violate the exclusion criteria. However, only 109 infants at preschool B did not meet the exclusion criteria. Therefore, we asked Preschools A and B to introduce us to neighboring preschools that were conducting WPR intake, and Preschool C in Urayasu City, Chiba, within 10 km of both preschools announced its participation. Preschool C also enrolled infants between the ages of 3 and 5 years. As in the past, the person in charge of preschool C excluded infants who did not meet the exclusion criteria, resulting in 131 infants participated in the study.

The number of COVID-19 cases was collected for each month of the fiscal year 2021 for those preschool infants for whom information was available. The same preschool that was infected in different months was not counted. We also accessed publicly available data from Koto-ku and obtained data for each month during the same period. Since detailed data by age were not available, we obtained data for the combined total of those aged 0 to over 90 as a reference for the incidence of infection in Koto-ku during the same month.

The total population within Koto-ku was defined as

the number of people disclosed on December 1, 2021. In addition, we obtained data on the number of people under 10 years of age affected by COVID-19 published by the Tokyo Metropolitan Government for each month during the same period. The total population under 10 years of age in Tokyo was defined as the number of people published by the Ministry of Health, Labour and Welfare on October 1, 2021.

Statistical Analysis

The total number of affected persons in each month in the SARFR and WPR groups was obtained: The total number of infants with or without COVID-19 infection in Preschool A with SARFR, and the total number of infants with or without COVID-19 infection in Preschool B with WPR, in 2021. Statistical analysis was performed using the statistical analysis software SPSS (Statistics27: IBM Japan, Chuo-ku, Tokyo), and a risk rate of less than 5% was considered a significant difference. Chi-square tests were performed on the total number of people with and without COVID-19 in Preschool A and B in the same area, Koto-ku, and the linkage coefficients of the Clamor of the effect size were calculated. Furthermore, the number of infants with or without COVID-19 in Preschool C with WPR was added to the total for Preschool B. A chi-square test was conducted for Preschool A and Preschools B & C, and the association coefficient for Clamor was calculated in the same way. For the number of COVID-19 cases in Koto Ward, the incidence rate was calculated based on the total number of people in the ward, and for the number of COVID-19 cases under 10 years in Tokyo, the incidence rate was calculated based on the total number of people in Tokyo.

Results

The total number of cases and incidence rates in each preschool, Koto-ku, and Tokyo in FY2021 are shown in ***Table 1***. The cumulative number of COVID-19 cases in Koto-ku is shown by month (***Fig. 1-a***). In Koto-ku, an increase in the number of cases was seen around summer, when the Delta strain became prevalent, and a large increase in the number of cases was seen with the outbreak of the Omicron strain from December. The cumulative number of COVID-19 cases per month in Preschools A and B in Koto-ku is shown (***Fig. 1-b***). Some cases occurred during the summer when the Delta strain was prevalent, and the number of cases increased after January, probably because the Omicron strain was prevalent from December onward. A chi-square test was performed on the total number of infants with and without infection, and a significant difference was found ($\chi 2$ (1) = 205.74, $p < 0.01$, $\phi = 0.61$). In addition, the monthly number of COVID-19 cases in Preschool C was added to Preschool B to show the cumulative number of cases (***Fig. 1-c***). The results of the chi-square test for the total number of infants with and without the infection showed a significant difference between Preschool A and Preschools B & C ($\chi 2$ (1) = 205.74, $p < 0.01$, $\phi = 0.49$). The cumulative monthly number of COVID-19 affected infants under 10 years of age in the public data of the Tokyo Metropolitan Government is shown (***Fig. 1-d***).

Discussion

This is a preliminarily study which examined whether the number of COVID-19 cases differed depending on the staple food between SARFR or WPR in the school lunches for 3- to 5-year-old preschool infants in Koto-ku, Tokyo. However, since the number of preschoolers consuming WPR was not large, we additionally recruited Preschool C at which infants consume WPR, located in Urayasu City, Chiba within 10 km distance from Preschool A and Preschool B. The chi-square test showed that a significantly smaller proportion of preschool infants in Koto-ku were affected by COVID-19 than those who received SARFR. The effect size was as high as 0.6, indicating that SARFR intake was associated with COVID-19 protection compared to WPR intake. In the results of the additional Preschool C, the proportion of COVID-19 cases was significantly lower in the preschool receiving SARFR, and the effect size was slightly lower than that in Koto-ku alone study, about 0.5 which is still enough high. The effect of SARFR intake on the reduction of COVID-19 incidence was suggested.

The monthly trends in the number of cases show an increase in the number of cases in Koto-ku starting around summer (***Fig. 1-a***). However, the impacts of Delta strains did not seem to be very high in the three preschools from which data were obtained, and there was no significant increase in the number of cases around summer in any of the preschools. Although the data from the Tokyo Metropolitan Government shows an increase in the number of cases of Delta strain in infants under 10 years of age (***Fig. 1-d***), it may be that there was no increase in the number of cases in infants aged 3 to 5 years, as in this study, or it may be that the number of cases of Delta strain in the participating preschools was not high. However, a significant increase in the number of cases of Omicron strain since December has been observed in preschools, in Koto-ku, and in Tokyo as a whole among those under 10 years of age. Omicron strains have been reported to cause many infections in infants, and the results of this study were similar[15]. Only in Preschool A, where SARFR was taken, there was no significant increase in the number of cases with Omicron strains, indicating that a significant difference was observed this time and that the effect size was high.

Since this study examined whether or not the staple food in preschoolers' school lunches was SARFR, there are research limitations, such as the fact that we do not know the children's diet at home. Furthermore, since the results were combined for 3- to 5-year-olds, it is not possible to say at what age the effect is most pronounced. The additional Preschool C with WPR intake is not located in Koto-ku, but in Urayasu City, Chiba. However, most of the area around Koto-ku is in Tokyo, and details on the number of affected infants in Urayasu City are not available, so the analysis in this study is limited by assuming that the number of affected infants is the same level as that in Tokyo.

However, since Preschools A, B and C are within 10 km of each other, this is not a study in a significantly distant area. At the very least, the fact that the Preschools A and B parks in Koto-ku are less than 3 km apart in a straight line suggests that there may be some association between SARFR intake and a decrease in the number of COVID-19 cases. However, it is difficult to say whether SARFR ingestion was

Table 1. Number of COVID-19 cases from 2021 April to 2022 March.

	Number of infected persons	Total number	Infection rate (%)
Preschool A	48	440	10.91
Preschool B	84	109	77.06
Preschool C	51	131	38.93
Koto-ku (0 ~ 99 years)	40,767	525,962	7.75
Tokyo (< 10 years)	150,881	1,032,000	14.62

The number of COVID-19 cases, and incidence rate that was calculated based on the total number of people were shown from 2021 April to 2022 March. **Preschool A**: a kindergarten in Koto-ku that consumed SARFR. **Preschool B**: a kindergarten in Koto-ku, located within a 3 km liner distance from A and consumed WPR. **Preschool C**: a kindergarten in Urayasu City in Tiba, located within a 10 km liner distance from A and B, and consumed WPR. Koto-ku: Publicly available data from 0s to 90s. The total population within Koto-ku was defined as the number of people disclosed on December 1, 2021. Tokyo: Publicly available data under 10 years. The total population under 10 years of age was defined as the number of people published by the Ministry of Health, Labour and Welfare on October 1, 2021.

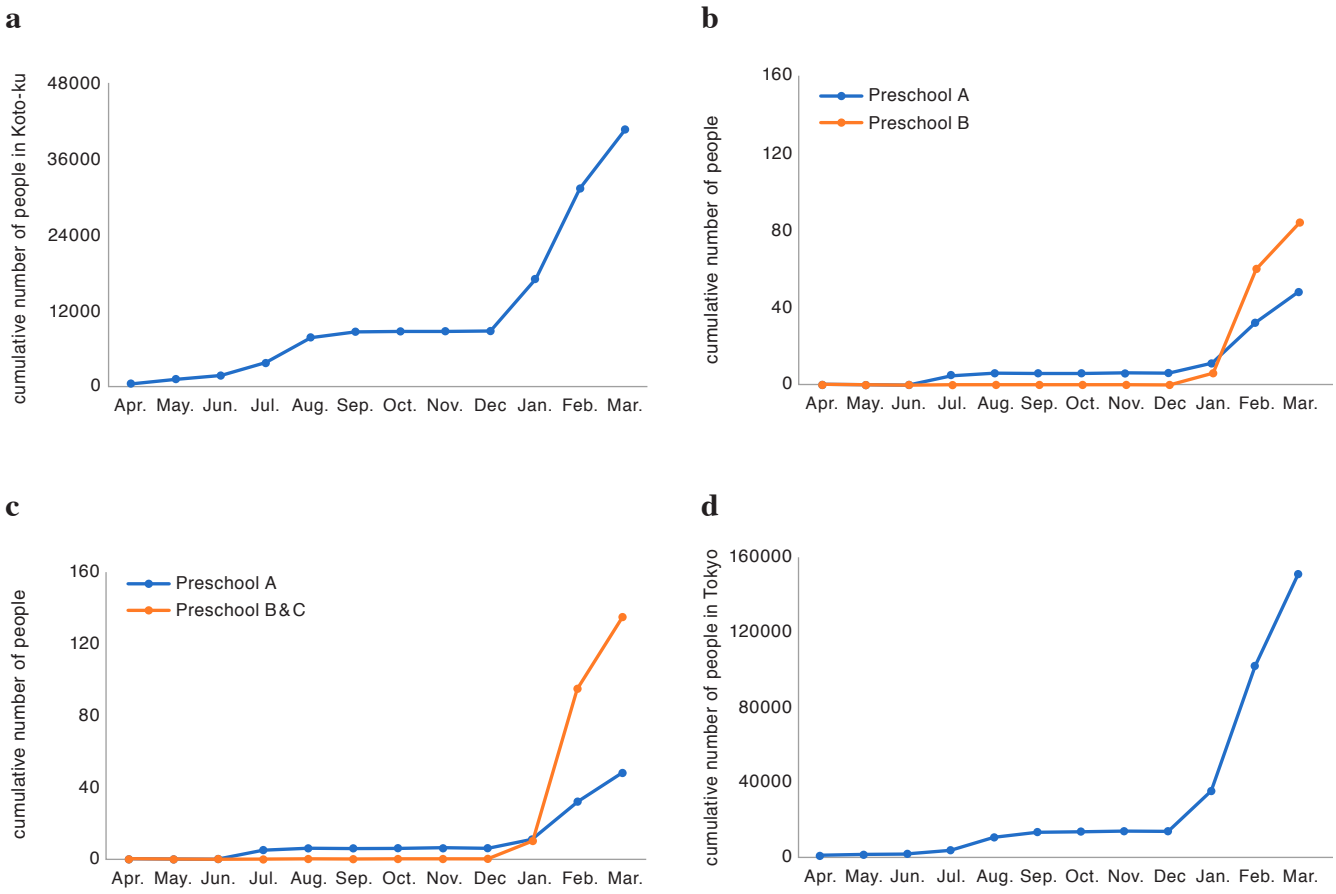

Fig. 1. **Monthly cumulative number of COVID-19 cases. a) in Koto-ku, Tokyo.**

The increase in the number of cases was observed due to the Delta strain outbreak from the summer and the Omicron strain from the end of the year. **a)** in Koto-ku. **b)** in Preschools A and B. **c)** in Preschools A, B and C. Cumulative number of COVID-19 affected patients in Preschools B and C combined. **d)** in Tokyo.

effective in protecting outbreaks specifically for the Omicron strain of COVID-19 or for outbreaks of infectious diseases in general.

Many studies have reported that brown rice contributes to good health[1,2,25]. It widely contributes to health by suppressing neutral fat[26], improving blood sugar levels[27], improving bowel movements[28], and having a positive effect on the intestinal microflora[29]. Furthermore, it has been shown to inhibit glycation, a factor in the formation of terminal glycation products, which is one of the important factors in aging and the development of lifestyle-related diseases[30]. In particular, γ-oryzanol, which is specifically contained in high concentrations in brown rice, has been suggested to improve brain function and prevent diabetes[31]. However, brown rice consumption tends to be avoided due to taste and texture issues, and its long cooking time makes it troublesome to prepare. Therefore, it is important to study the health effects of processed brown rice, such as the SARFR used in this study, which solves the aforementioned problems and is also good for digestion.

It has already been shown that SARFR has a positive effect on the skin[21]. Furthermore, activation of immune function by SARFR ingestion has been noted[23,24]. Although the results of the present study are preliminarily results, they suggest a possible contribution of SARFR intake to the prevention of infectious diseases in infants. Future studies on adults to determine whether processed brown rice, as well as SARFR, influences the prevention of infectious diseases may be useful in preventing infection without vaccination, as well as in studying the mechanisms of infection and immune function, which remain unclear. Furthermore, it has been pointed out that nutritional imbalance due to dietary changes caused by the COVID-19 epidemic is occurring in children[17,18]. The most of previous studies have focused on adults and have not actively examined the health effects of processed brown rice on infants. In the future, the health effects of processed brown rice consumption will need to be examined in infants.

Conclusion

As a preliminarily study, we examined whether the number of COVID-19 affected preschool infants in the year 2021 stored in kindergartens and nursery schools differed depending on whether they consumed one type of processed brown rice, SARFR, a total of approximately 680 infants aged 3 to 5 years. The results showed that the number of COVID-19 cases among preschoolers who consumed rice with a residual sub-aleurone layer tended to be lower than among those who consumed WPR. Further studies are needed to determine the effect of rice with sub-aleurone layer on the prevention of infectious diseases.

Conflict of interest declaration

In conducting this study, Meal Care Corporation conducted recruitment at preschools that provide school lunches.

Acknowledgments

This study was supported by the Foundation for Isyoku-Dogen Syoyaku Research.

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