

Original paper

## Report from Izumiotsu Maternity Support Project: Next Generation Aid

Masatoshi Ukezono<sup>1,3)</sup>, Kenichi Minamide<sup>2)</sup>, Keiji Saika<sup>3,4)</sup>, Hideto Nakayama<sup>2)</sup>, Yae Fujiwara<sup>2)</sup>, Hirokazu Miyazaki<sup>2)</sup>, Yukako Mukai<sup>2)</sup>, Tomoko Nagamoto<sup>2)</sup>, Tomoyuki Miyashita<sup>2)</sup>, Eriko Furukawa<sup>2)</sup>, Naoki Nishiyama<sup>3)</sup>, Anhar M. M. Alrayes<sup>5)</sup>, Masayuki Yagi<sup>5)</sup>, Yoshikazu Yonei<sup>3,5)</sup>

1) Department of Environmental Information, Faculty of Comprehensive Environmental Studies, University of Human Environments, Matsuyama, Ehime, Japan

2) City of Izumiotsu, Osaka, Japan

3) (Public Interest Incorporated Foundation) Isyoku-Dogen Research Foundation, Tokyo, Japan

4) Tokyo University of Agriculture, Tokyo, Japan

5) Doshisha University, Faculty of Life and Medical Sciences, Anti-Aging Research Center/Glycation Stress Research Center, Kyoto, Japan

### Abstract

**Objective:** As a preliminary study, we focused on the effects of the intake of processed brown rice on pregnant women and their children. In particular, we focused on the weight of the newborns.

**Method:** This study involved participants answering questionnaires twice, once when they applied to participate and once after giving birth. The method for providing processed brown rice, sub-aleurone layer residual wash-free rice (SARFR), during pregnancy was to have participants apply for it themselves, so that they could consume the rice without interruption.

**Results:** Pregnant women showed improvements in early satiety, constipation, edema, sweating, sensitivity to the cold, and sleep quality. The more satisfied participants were with the project, the greater the improvements in their eyes, weight, colds, and headaches. There was a significant increase in the weight of infants at the one-month checkup compared to the average weight from FY 2019 to FY 2022.

**Conclusion:** The intake of SARFR reduced physical discomfort and skin problems during pregnancy, suggesting an increase in the weight of the newborn. In the future, it will be necessary to conduct a large-scale study to examine the effects of the intake of processed brown rice during pregnancy on the weight of newborns.

**KEY WORDS:** sub-aleurone layer residual wash-free rice (SARFR), low birth weight, pregnant women, newborns, Izumiotsu City

### Introduction

In recent years, it has been shown that the number of low birth weight (LBW) infants in Japan has been increasing since 1990<sup>1)</sup>, with LBW being defined as those weighing less than 2,500 g. The proportion of LBW infants has been increasing since 1980, and since 2005, it has remained at about 9.5% despite the declining birth rate. This suggests it is always included at a constant ratio, and the average weight of newborns is expected to continue to decline in the future<sup>1)</sup>.

What is noteworthy about this report is that, according to a longitudinal survey of monthly weights from 0 to 12 months of age, the average weight in 2010 has decreased from around one month after birth compared to 1990 and 2000. Growth retardation has been reported to be associated with severe disabilities such as intellectual disability<sup>3)</sup>, autism spectrum disorder<sup>4)</sup>, and attention deficit hyperactivity disorder<sup>5)</sup>. In particular, in Japan, it has been reported that LBW infants are at higher risk of autism spectrum disorder and chronic

Contact Masatoshi Ukezono

Faculty of Comprehensive Environmental Studies, Department of Environmental Information, University of Human Environments  
9-12 Himata, Dogo, Matsuyama, Ehime 790-0825

TEL: +81-89-926-7007 e-mail: m-ukezono@uhe.ac.jp

Co-authors; Minamide K, hisyo@city.izumiotsu.osaka.jp; Saika K, somu@toyo-rice.jp; Nakayama H, senryaku@city.izumiotsu.osaka.jp; Fujiwara Y, kosodate@city.izumiotsu.osaka.jp; Miyazaki H, senryaku@city.izumiotsu.osaka.jp; Mukai Y, kosodate@city.izumiotsu.osaka.jp; Nagamoto T, kosodate@city.izumiotsu.osaka.jp; Miyashita T, senryaku@city.izumiotsu.osaka.jp; Furukawa E, kosodate@city.izumiotsu.osaka.jp; Nishiyama N, nishiyama@toyo-rice.jp; Al-Rayes MMA, ctuk5102@mail4.doshisha.ac.jp; Yagi M, myagi@mail.doshisha.ac.jp; Yonei Y, yyonei@mail.doshisha.ac.jp

attention deficit hyperactivity disorder<sup>6</sup>), as well as a higher risk of chronic kidney disease<sup>7</sup>. Causes of LBW include weight loss in pregnant women, increased stress, and late marriage<sup>2</sup>).

Therefore, research on the optimal weight for newborns has been conducted, and a survey of 100,000 couples in Japan has reported that low weight gain during pregnancy increases the rate of LBW and large births<sup>8</sup>. Conversely, it has been reported that significant weight gain during pregnancy increases the risk of developing pregnancy-induced hypertension and gestational diabetes after birth. A weight gain of 7 kg or less during pregnancy increased the risk of LBW<sup>9</sup>. However, there is a report that states the risk of LBW decreases with a high-quality diet<sup>10</sup>. Therefore, it is considered important for both newborns and pregnant women to consume sufficient solid nutrients during pregnancy. In response, the Izumiotsu City Government (Osaka, Japan) planned and implemented a maternity support project in FY 2023, aimed at reducing the risks for newborns and pregnant women by providing pregnant women with processed brown rice, a highly nutritious rice dish, free of charge. As a preliminary study, this survey focused on the effects of processed brown rice on pregnant women. Considering that this project is expanding to other prefectures, the research report will include the name of the region in front of "Next Generation Aid," and the title of this paper will be "Izumiotsu Next Generation. Aid"

## Methods

### Agreement

At the start of the study, a comprehensive collaboration agreement was concluded between the Isyoku-Dogen Foundation and Izumiotsu City Government.

#### Agreement on Comprehensive Collaboration between Izumiotsu City and the Isyoku-Dogen Research Foundation

##### (Purpose)

##### Article 1

Izumiotsu City (hereinafter referred to as "Party A") and the Isyoku-Dogen Research Foundation (hereinafter referred to as "Party B") will promote mutual collaboration that respects the perspectives of medical and food-based herbal medicine, and will analyze health issues in Party A's region and conduct research led by Party B. In addition, the purpose is to create new social value and promote the health of citizens, leading to preventive measures to reduce medical expenses in the region and the development of the local community.

##### (Matters of collaboration)

##### Article 2

After consultation between Party A and Party B, in order to achieve the purpose of the previous article, Party A and Party B will collaborate and cooperate on the following matters. (1) Matters related to promoting the health of citizens (2) Matters related to the analysis and interpretation of health issues in Party A's region (3) Matters related to the promotion of Party B's research using Party A's field (4)

Other matters necessary to achieve the objectives of this agreement 2 Specific implementation matters will be decided through consultation between Party A and Party B.

##### (Review and termination of the agreement)

##### Article 3

When either Party A or Party B requests changes to the contents of the agreement or its termination, the necessary changes or termination will be made following consultation each time.

##### (Period)

##### Article 4

The validity period of this agreement will be from the date of its conclusion of the agreement to March 31, 2025. However, unless Party A or Party B requests the other party to terminate the agreement in writing one month prior to the expiration date, this agreement will be renewed for another year, and the same shall apply thereafter.

##### (Confidentiality)

##### Article 5

Party A and Party B shall not disclose, provide or leak to a third party any confidential information that they learn in the course of carrying out the matters set out in Article 2, nor shall they use such information for purposes other than those of the initiatives under this Agreement. However, this does not apply if the other party gives prior written consent. 2 The obligations set out in the preceding paragraph shall survive the termination of this Agreement.

##### (Resolution of doubts)

##### Article 6

If doubts arise regarding matters not specified in this Agreement, or matters specified within this Agreement, Party A and Party B shall negotiate in good faith to reach a settlement. As evidence of the above and the conclusion of this Agreement, two copies of this Agreement shall be prepared, and Party A and Party B shall each sign and seal one copy and retain one copy.

January 26, 2023

Party A: 9-12 Shinonome-cho, Izumiotsu-shi, Osaka  
Mayor of Izumiotsu City: Kenichi Minamide  
Party B: 5-10-13 Ginza, Chuo-ku, Tokyo  
Isyoku-Dogen Research Foundation  
Representative Director: Yoshikazu Yonei

### Subjects

The number of subjects for this analysis was 101, all of whom applied for "Maternal and Child Health Handbook" between April 1, 2023 and August 14, 2023. The survey contents were explained to participants at the time of participation, and written consent was obtained. The percentage of consenters was 70.1%.

### Procedure

At the time of pregnancy notification, 2 kg of processed brown rice was given along with the mother-child handbook.

The survey was conducted by having the participants complete a questionnaire at the time of application for participation and again after the birth of the baby. All questionnaires were administered on the web via smartphone. The URL for the survey was provided as a two-dimensional (2D) barcode on a flyer provided at the time of pregnancy notification, and participants were asked to use the barcode themselves to complete the survey. After the first 2 kg package of processed brown rice was delivered during pregnancy, two 5 kg packages were sent to the participants' homes, along with a flyer containing a 2D barcode for additional orders. Subsequently, each time the processed brown rice ran out, the participants were asked to apply for it themselves using the 2D barcode, so that they could consume an uninterrupted supply of processed brown rice.

The questionnaire survey used the Edinburgh Postnatal Depression Scale (EPDS)<sup>11,12</sup> and the Anti-Aging QOL Common Questionnaire<sup>13,14</sup>. This questionnaire was uploaded onto the web. A systems engineer set it up so that participants could easily answer the questionnaire using their own smartphones while also ensuring smooth data collection.

### Cooperation system by the City

The management of the entire project was led by Izumiotu City Mayor Minamide himself. On-site management (including the investigation and planning the distribution of processed brown rice, and data verification) was carried out by the Growth Strategy Division of the Mayor's Office (General Manager Miyashita). Data entry and organization in accordance with procedures were carried out by several staff members in the relevant department. Information about the project (distribution of flyers) to pregnant women according to procedures was carried out by several staff members on a rotating basis.

### Food information on processed brown rice

The test rice used in this study was processed brown rice called "sub-aleurone layer residual wash-free rice (SARFR)" (marketed as Kinme-rice), which was made by gradually removing the bran from the surface of brown rice using a special rice polishing machine, leaving the "sub-aleurone layer" evenly on the surface of the rice grains<sup>15-17</sup>. The sub-aleurone layer contains vitamins, minerals, dietary fiber, as well as rice bran oil components ( $\gamma$ -oryzanol)<sup>18-21</sup>, lipopolysaccharides (LPS), ferulic acid<sup>22</sup>, and phytic acid. Various benefits contributing to glycative stress reduction have been reported<sup>15-17, 23</sup>. The nutritional components of brown rice improve postprandial hyperglycemia<sup>24</sup> and inhibit the production of advanced glycation end products (AGEs)<sup>22</sup>, thereby contributing to the reduction of glycative stress.

The sub-aleurone layers is a highly "wasteful" component that is discarded in a standard rice polishing process. A survey of medical expenditures has shown that the consumption of processed brown rice may contribute to reducing public medical costs<sup>25</sup>. A study comparing differences in school lunches at kindergartens reported that facilities that provided processed brown rice had a lower incidence of COVID-19 infections among children than facilities that did not<sup>26</sup>. The safety of processed brown rice has been confirmed in previous clinical studies<sup>15-17, 23</sup>.

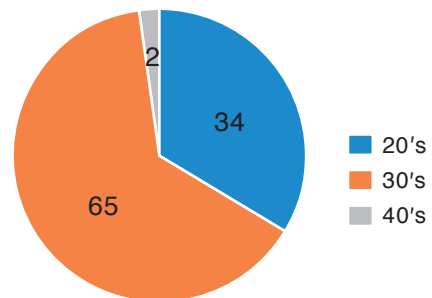
### Ethical standards

This study was conducted based on the "Agreement on Comprehensive Collaboration between Izumiotu City Government and the Isyoku-Dogen Foundation".

## Results

### Physical information of participants

The age distribution of participants is shown in [Fig. 1](#), and the mean and standard deviation of the number of participants in the household size, age, height, and weight of the participants are shown in [Table 1](#). The majority of participants were in their 30s, and there were two participants in their 40s. There were no significant differences in height and weight, which were generally similar across participants. Based on the number of subjects in each household, the data indicated that many of the participants were likely to be first-born children. However, because the data only reflect the number of subjects in the household, it was not possible to say whether it was a first birth or a second or subsequent birth.



**Fig. 1.** Number of participants by age group.

**Table 1.** Participant information.

n = 101	Mean	SD
Number of people per household	2.85	0.79
Age	30.90	3.81
Height	159.32	4.92
Weight	59.49	7.87

SD, standard deviation.

### Survey results

[Table 2](#) shows the results of the survey conducted at the end of the project. Most of the respondents were satisfied or above. When asked whether they would recommend the project to other pregnant women, almost all of them, except for two who answered that they were neutral, indicated that they would recommend it.

Four subjects answered that they were dissatisfied or very dissatisfied with the project, citing little change in their

physical condition. One person had asthma, insomnia, and spent more than 10 hours a day using VDT (visual display terminals) screens such as computers, mobile phones, and televisions (hereinafter referred to as VDT work time). One person had difficulty falling asleep, severe swelling, and insomnia. One person frequently suffered from stiff shoulders, eye fatigue, and palpitations, and also had insomnia and spent more than 8 hours a day working on VDTs. The remaining person did not have any clearly severe symptoms. Three of the four subjects answered that the amount of SARFR was insufficient. However, three out of four subjects chose the project as being at least suitable for recommending to other pregnant women, suggesting that the project itself was well-received enough for them to recommend it to others.

The change in each questionnaire result between the time of application and the end of the project was calculated by subtracting the score of the time of application at the end.

**Table 2. Thoughts on the project.**

How satisfied are you with participating in the project?	Very satisfied	78
	Satisfied	18
	Neutral	1
	Unsatisfied	2
	Very unsatisfied	2
Would you recommend this project to other pregnant women?	Would recommend	83
	May recommend	16
	Neutral	2
	Not really recommended	0
	Wouldn't recommend	0
Quantity of Kinme-rice	There was quite a lot	0
	There was a little too much	7
	Just right	82
	There wasn't enough	9
	There wasn't enough	3
Changes in physical condition after eating Kinme-rice	Much better	9
	Improved	27
	Not much different	65
	Worsened	0

Therefore, the larger the negative value, the greater the degree of improvement in that item. A correlation analysis was performed on the relationship between this change and satisfaction with the project, and a significant relationship was found for many variables (**Table 3**). Since the change in each questionnaire result between the time of application and the end was used, the greater the change, the more likely it was that participants would select "1" (indicating high satisfaction), resulting in a negative correlation value. The larger the value, the greater the change, indicating a tendency for high satisfaction. Furthermore, a t-test was performed to examine items with large differences between the time of application and the end of the questionnaire results, and it was shown that symptoms had improved significantly in the items in **Table 3**. Furthermore, the effect size was calculated to show which items had the greatest effect among the items where differences were detected. The higher the effect size, the greater the effect of that item.

### *Birth weight and weight at 1-month checkup*

As an additional analysis, follow-up data from prenatal checkups, birth, and 1-month checkups were obtained. A total of 87 subjects participated in the follow-up. There were 14 subjects who moved outside the prefecture or who underwent a one-month medical checkup outside the prefecture. The weights at birth and 1-month checkups are shown in **Table 4**. To examine whether there was a difference between the average birth weights from FY 2019 to FY 2022 and the average birth weights after the intervention, one-sample t-tests were performed for each, and no differences were found. However, at the 1-month checkup, there was a significant difference between the average weights from FY 2019 to FY 2022 and the 1-month checkup after the intervention, and there was a significant tendency for a difference between FY 2022 and FY 2024. The effect size exceeded 0.3, indicating that the weight at the 1-month checkup after the intervention may be larger than before.

**Figure 2** shows a line graph of the data from FY 2019 to FY 2022 and in FY 2024 after the intervention for birth and one-month checkup weights, with a regression line included. Although no significant differences were found in birth weight

**Table 3. Items with significant relationships and differences between the time of application and the end of the project.**

Items that showed a significant relationship with satisfaction	Correlation coefficient	Items that showed a significant difference (tendency) in the before-and-after comparison	p value/effect size
Blurred vision	-0.26	Weight loss	0.08 / 0.17
Weight loss	-0.25	Skin problems	0.06 / 0.19
No sense of health	-0.23	Early satiety	0.06 / 0.19
Thirsty	-0.25	Constipation	0.02 / 0.22
Skin problems	-0.28	Edema	0.09 / 0.17
Easily catches colds	-0.33	Excessive Sweating	0 / 0.29
Cough/Sputum	-0.29	Sensitivity to the cold	0 / 0.31
Hair loss	-0.35		
Headaches	-0.35		
Sweating easily	-0.22		
Depression	-0.25		

from FY2019 to FY2022, an increasing trend was observed after the intervention. For the 1-month checkup weight, where significant differences have been observed, a large and steady increase is evident. Compared to the predicted weight when the regression line is extended to FY2024, the post-intervention weight has shifted upward. This report is a preliminary report for a period of approximately 3.5 months. A survey over the course of one year would reveal whether weight gain is occurring due to the consumption of processed brown rice.

The proportion of LBW infants among all newborns was calculated and examined from FY 2019 to FY 2022 and at the end of the intervention in FY 2024. No statistical difference was found ( $\chi^2 = 3.72$ ,  $p = 0.45$ , not significant), and the changes

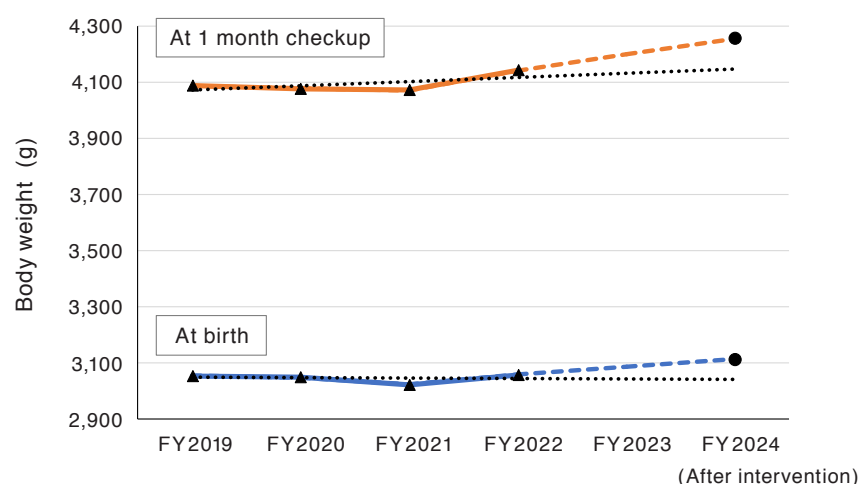
seen since FY 2005 do not appear to be significantly different from previous reports<sup>1)</sup>. **Figure 3** illustrates the proportion of LBW infants and their predicted values from FY 2019 to FY 2022 and at the end of the intervention in FY 2024. While the accuracy of the predicted proportion is not high due to the small sample size, it appears that the proportion of LBW infants at the end of the intervention has decreased compared to FY 2020 and FY 2021.

Since the proportion of LBW infants has also decreased in FY 2022, it is believed that the administrative services provided in Izumiotu City to date have significantly contributed to the reduction in LBW infants, as well as the effect of this intervention.

**Table 4. Comparison of weight at birth and at one-month checkups every year since FY 2019 with weight after this intervention.**

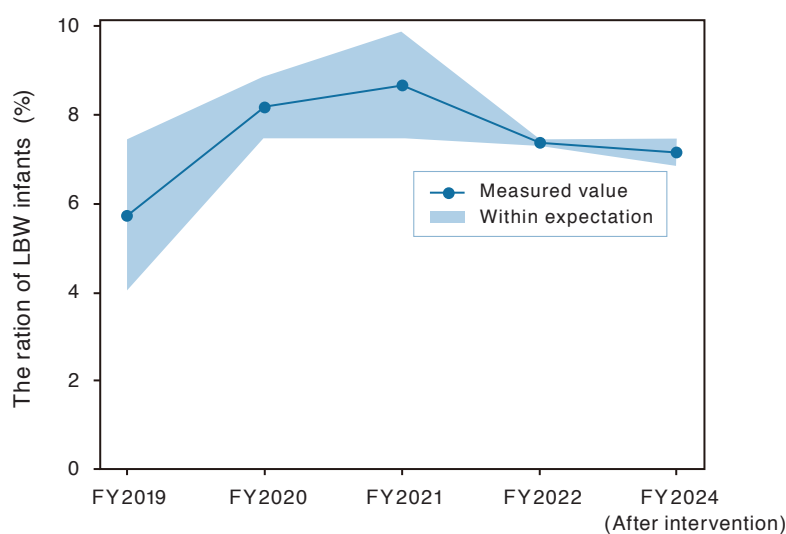
	FY 2019	FY 2020	FY 2021	FY 2022	FY 2024 (Intervention results)
Subjects (number)	524	479	520	449	83#
Average birth weight (g)	3055.0	3048.8	3023.7	3058.3	3114.6
Normal weight 2,500 ~ < 4,000 g (number [%])	494 [94.3 %]	439 [91.6 %]	475 [91.3 %]	415 [92.4 %]	78 [92.9 %]
LBW < 2,500 g	30 [5.7 %]	39 [8.1 %]	45 [8.7 %]	33 [7.3 %]	6 [7.1 %]
Very LBW < 1,500 g	0 [0.0 %]	1 [0.2 %]	0 [0.0 %]	0 [0.0 %]	0 [0.0 %]
Extremely LBW < 1,000 g	0 [0.0 %]	0 [0.0 %]	0 [0.0 %]	1 [0.2 %]	0 [0.0 %]
Average weight at 1 month checkup (g)	4087.1	4077.4	4071.1	4140.5	4253.8
t-test comparing intervention result weight at birth (t-test [p value])	0.234	0.190	0.072	0.262	
Comparison with intervention result weight at 1 month checkup (t-test [p value])	0.006	0.004	0.003	0.060	
Comparison with intervention result weight at 1 month checkup (effect size)	0.308	0.326	0.337	0.209	

# The number of subjects were 101 enrolled between April 1, 2023 and August 14, 2023, of which the birth weight of 83 children was available for analysis. FY, fiscal year; LBW, low birth weight.



**Fig. 2. Changes in birth weight and 1-month checkup weight in Izumiotu City, and post-intervention weight.**

The regression line calculated from the average weight (▲) from FY 2019 to FY 2022 is shown with a black dotted line. The weight of post-intervention newborns (n = 83) has shifted upward from the regression line as of FY 2024. Data are derived from **Table 4**.



**Fig. 3.** Trends in the proportion of LBW infants in Izumiotsu city and the proportion after the intervention. Proportions values from FY 2019 to FY 2022 are tallied by the city. Data in FY 2024 shows the results after the intervention (n = 83).

## Discussion

### Questionnaire survey resultsp

Statistical analysis (Student's t-test) revealed that the intake of processed brown rice affected the physical condition of pregnant women in many areas (Table 3: right). When the results were analyzed by age group, there was a large difference in "Weight loss" in those in their 30s, but no change was observed in those in their 20s and 40s. Because the effect was large in those in their 30s, a t-test was conducted overall, and it was found to be an item where a difference was detected. Since no change was observed in those outside their 30s, the overall effect was not high. "Skin problems" and "Early satiety" also improved significantly in those in their 30s, but no change was observed in those in their 20s and 40s, showing a trend similar to that of "Weight loss". "Constipation" improved in those in their 20s and 30s. The effect size was also the third highest among those where differences were detected this time, indicating that there is a positive effect on "Constipation". However, since "Early satiety", "Constipation", and "Edema" often improve after childbirth, it is difficult to determine from this survey whether this is due to the effect of processed brown rice or because the questionnaire was taken after childbirth. "excessive sweating" improved in both women in their 20s and 30s, showing a high degree of effectiveness. However, it is unclear whether this is due to the change in hormone balance during pregnancy, which normalized after childbirth, or whether this is due to the effect of processed brown rice. The greatest effect was an improvement in "Sensitivity to the cold", which showed a large improvement in women in their 30s. No change was detected in women in their 20s and 40s, but the improvement was large in women in their 30s, indicating that there was a considerable effect. Furthermore, sleep quality also showed a large improvement in women in their 30s. From these results, it is difficult to conclude that this is the effect of processed brown rice, but

the results at least show that each item improved before and after consuming processed brown rice, which is considered to be sufficient for empirical consideration.

It was also found that higher satisfaction levels were associate with an improvement in the symptoms of eyes, weight, colds, and headaches. (Table 3: left). Differences were observed in the t-test, showing that satisfaction increased due to improvements in thinness/weight loss, skin problems, and excessive sweating. There was a correlation between improvement of blurred vision and increased satisfaction, and it was found that the improvement of physical problems is important in contributing to satisfaction. It is noteworthy that there is a strong correlation between the improvement of items related to colds or allergic rhinitis, such as upper respiratory tract infections (common cold), headaches, coughs, sputum, and satisfaction. Although there was no difference in these items in the t-test comparing before and after the intake of processed brown rice, the correlation analysis showed that the higher the satisfaction level, the more improvement in these items occurred. It has been reported that contracting a cold during pregnancy affects the fetus and increases the likelihood that the newborn will develop hearing loss, retinitis, and developmental disorders<sup>27,28</sup>. Improvement in cold symptoms leads to the possibility of avoiding colds, demonstrating the significance of consuming processed brown rice. Furthermore, the strong correlation between the improvement in depressive symptoms and satisfaction is a significant result. It is known that depressive symptoms during pregnancy affect subsequent maternal-child bonding, attachment formation, and birth<sup>29</sup>. Although there was no difference in the t-test, the improvement in depression symptoms before and after the intake of processed brown rice along with the strong correlation with satisfaction, suggests that the improvement may be relate to the intake of processed brown rice. Therefore, the effect of consuming processed

brown rice extends beyond physical symptoms to include psychological benefits. Of course, this may be due to a sense of security that the city is implementing measures for pregnant women such as this project (see participants' impressions), but in any case, the analysis suggests that many subjects are satisfied with the project and that positive physical and psychological effects have been observed.

### *Birth weight and weight at one-month checkup*

In order to examine the causes of increased weight, the objective variable was set as the weight at the one-month checkup, and in order to identify the items of the explanatory variables, 1) a t-test was conducted on all items using the data of 87 subjects to determine if there were differences in the amount of change between the post-questionnaire and the pre-questionnaire, and 2) the correlation between "Satisfaction with participating in the project" and all items was calculated. As a result of the analysis in 1), the items with an effect size exceeding 0.5 in particular were blurred vision, skin problems, back pain, anger, inability to solve problems, sleep time, and sleep quality, and there was a significant difference or significant tendency at the 5% level. The results were somewhat different from those of the 101 subjects before the follow-up survey. As a result of the correlation analysis in 2), the items with a correlation of 0.2 or more were blurred vision, skin problems, susceptibility to catching colds, hair loss, and headache. The above items were used as explanatory variables, and in addition, the amount of SARFR, changes in physical condition after eating SARFR, and the age, height, and weight of the pregnant woman were added to the explanatory variables, for a total of 15 items. The explanatory variables for each of the pregnant women, except for their age, height, and weight, were calculated by subtracting the pre-survey results from the post-survey results. At this time, data from participants with missing values was deleted, so the final sample size was 83 subjects.

When multiple regression analysis was performed with the weight at the one-month checkup as the objective variable, the model validity was low, so explanatory variables were selected again. Blurred vision and skin problems, which had already been shown in the results of 101 subjects, were selected as explanatory variables, and the amount of SARFR, changes in physical condition after the consumption of SARFR, and the age, height, and weight of the pregnant woman were selected as explanatory variables. In addition, sleep time and VDT work time related to sleep time, which have already been shown to be related to the weight of the newborn in previous studies, were also added as explanatory variables. This resulted in a total of nine explanatory variables. Each explanatory variable other than the age, height, and weight of the pregnant woman was calculated as the change obtained by subtracting the results of the pre-survey from the results of the post-survey. When multiple regression analysis was performed with the weight at birth as the objective variable, the model validity was low, so interpretation was not possible. In addition, there were too few pregnant women who were eligible for analysis regarding anemia, diabetes, and problems related to the results of the one-month checkup. In addition, no relationship was found for the EPDS value, even when considering the above-mentioned explanatory variables or all items.

However, the possibility of weight gain at the one-month checkup compared to previous years is likely due to the influence of processed brown rice intake, and it is desirable to conduct a larger-scale study in the future on the impact of processed brown rice intake on the weight of newborns. The issue of LBW is an urgent issue in Japan, making it a matter of high importance. In addition, future studies should explore whether the intake of processed brown rice improves poor health and increases VDT work hours, and whether the intake of processed brown rice contributes to the weight gain of newborns as a result of reducing poor health and skin problems during pregnancy.

### **Conclusion**

Preliminarily, the effects of consuming processed brown rice during pregnancy on the mother and child were examined in a total of 101 subjects. The results showed a reduction in subjective symptoms of poor physical condition during pregnancy, as well as a decrease in skin complaints. A significant increase was observed in the weight of one-month-old infants compared to the average weight of the city from FY 2019 to FY 2022. These findings suggest that providing processed brown rice to pregnant women may be beneficial for improving quality of life during pregnancy and preventing LBW. In the future, a large-scale study should be conducted to determine the effects of processed brown rice consumption on the weight of newborns, and the mechanism of improvement of maternal health condition should be investigated. Future studies need to be conducted on a large scale to examine the effects of processed brown rice intake during pregnancy on the weight of newborns.

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### **Conflict of interest declaration**

None in particular.

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