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# The importance of social oocyte cryopreservation in supporting local municipalities: A prospective study

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## Abstract

**Background:** With the trend toward late marriages and late childbearing, cryopreservation of oocytes for fertility preservation is attracting attention as a method to counteract the declining birthrate.

**Objectives:** To examine the impact of social oocyte cryopreservation on local communities by assessing the significance of government assistance for cryofreezing and capturing the participants' subsequent feelings regarding this assistance.

**Design:** Descriptive study

**Methods:** A prospective study was conducted on city-dwelling women <35 years old attending monthly seminars on oocyte retrieval/cryopreservation to whom the study concept was explained. Egg collection and storage management costs were free for 3 years after the project completed, and subsequent actual storage costs were borne by the individuals. After oocyte retrieval, we conducted a questionnaire on oocyte cryopreservation and administrative assistance.

**Results:** Of the 62 seminar participants, 2 became pregnant naturally without oocyte retrieval. Oocytes were retrieved in 34 women (average age: 32.8 years, number of oocytes obtained: 8.3), among whom 4 subsequently became pregnant and gave birth through natural pregnancy or artificial insemination, and 1 became pregnant and gave birth using frozen oocytes. In a follow-up questionnaire given to these 34 subjects, all responded that they were glad to have oocyte cryopreservation, but 23 subjects (67.6%) answered that they could not perform cryopreservation without financial assistance. Twenty-five participants (73.5%) wanted to try to conceive without using frozen oocytes as a post-cryopreservation plan.

**Conclusions:** As a countermeasure against the declining birthrate, oocyte cryopreservation and associated workshops that can provide the information and education needed to conduct this task in a "planned" manner may be useful in providing women with additional reproductive options. Financial assistance will also be required to offer this service to the women who need it.

## Plain language summary

### Women benefit when egg freezing is subsidized by local municipalities

Why was the study done? To prospectively examine the significance of egg freezing in a society in which the declining birthrate is an issue, particularly with regard to those who wish to undergo egg freezing and their trends when it is supported by the government. What did the researchers do? This project was conducted as a three-year endowed course by a local city government. Participants were women aged 20 to 34 who lived in the city and were recruited through the city's newsletter and website. They then attended a fertility workshop that was held once a month. Participants who wished to freeze their eggs were offered one free egg retrieval and three years of frozen storage. Participants were also asked to complete a questionnaire about their progress three years after the project ended. What did the researchers

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find? Sixty-two women participated in the three-year project, of whom 34 chose to freeze their eggs. Those who did not plan to conceive early, and two conceived naturally. Of those who froze their eggs, only one gave birth using the frozen eggs, and seven conceived naturally or through fertility treatments without using frozen eggs, two of whom had two pregnancies, resulting in 10 children being born. What do the findings mean? Three years after the project ended, the findings suggested that egg freezing itself may not have had a significant effect on pregnancy and childbirth but that holding workshops on fertility may have acted as an incentive for women to become pregnant and give birth.

**Keywords**
birthrate, delayed childbearing, fertility preservation, nonmedical oocyte cryopreservation, oocyte cryopreservation, oocyte warming, planned oocyte cryopreservation, preconception care, reproduction, vitrification

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## Introduction

The delay of marriage and childbirth as a result of the social advancement of women is considered an underlying factor driving the declining birthrate. Women receive little support for childcare costs and social welfare, thus forcing many to delay pregnancy and childbirth.[1] However, the outcomes of infertility treatment in older women are disappointing.[2] Social funding for oocyte cryopreservation has been proposed as a potential countermeasure, but there are benefits and disadvantages to this approach.[3]

Women continue to delay marriage due to their increased level of education, employment opportunities, and economic position, and thus are also increasingly delaying childbirth. It takes time to build a stable career, and the infrastructure to enable the continued social advancement of women is lagging behind the times. There is also a significant gender gap resulting from the traditional roles of men and women in Japanese society,[4] so the fact that marriage is no longer economically essential for women has increased their options. By prioritizing their career during the ideal time to start a family, many women are now missing the opportunity to become pregnant.[5]

Also problematic are the excessive expectations placed on infertility treatment,[6] particularly in Japan, where sex education is often delayed and there is a lack of awareness of education on fertility. Over 40% of Japanese women believe that they will have the same level of fertility in their 40s as in their 30s, and an international survey on the awareness of pregnancy and childbirth found that less than 40% of Japanese women possessed an adequate understanding of fertility (compared to 64% in other countries). A survey performed on university students found that 36.6% believed it possible for a woman to spontaneously become pregnant in her 50s, and 5.4% even into her 60s, indicating the dissonance between reality and understanding.[7] When assisted reproductive techniques are used in Japan, a mean amount of 1,974,000 yen is required to birth a single child. According to the literature, a woman at the start of her 30s will need 1.2–1.7 million yen, whereas a woman starting her 40s will require approximately 5 million yen.[8]

The first pregnancy and birth in the world resulting from human oocyte cryopreservation was reported by Chen in 1986,[9] whereas that from Japan was published in 2001 by Kyono et al.[10] Advances in oocyte cryopreservation techniques (switching from slow freezing to vitrification) have enabled successful pregnancies and deliveries.[11] By 2009, infant safety had been verified in over 900 cases,[12] so the American Society for Reproductive Medicine approved cryopreservation as clinical therapy equivalent to fresh embryos in terms of insemination and pregnancy rates.[13]

Cryopreservation of unfertilized oocytes may offer women who are infertile, or currently do not wish to have a child, the opportunity to mother a genetically related child. Although it is unclear what effect cryopreservation might have on infertility patients, it may offer women who currently do not wish to have children an opportunity to become the mother of a genetically related child. In 2006, Woodruff from America first proposed the concept of oncofertility as a means for young cancer patients to preserve their fertility.[14] The number of patients who have overcome cancer continues to increase due to improvements in cancer diagnosis and multidisciplinary treatment. However, some forms of chemotherapy and radiotherapy are reportedly reprotoxic, so fertility-preserving therapy is recommended before initiation of anticancer treatment.[13] Oocyte cryopreservation is ethically permissible as a form of medical therapy that promotes social equality.[15]

In this study, we cooperated with Urayasu city, a commuter town adjacent to Tokyo for people working in the metropolis, with the aim of raising the awareness of fertility while providing seminars on the current state of infertility treatment. We also obtained grants from the city to conduct unfertilized oocyte cryopreservation to investigate in the form of a prospective study whether this could be a solution to the current situation. Our project was

mentioned in the mass media at that time, likely because the declining birthrate in Japan has become a big problem. We have already published an interim report of our findings.[16] One participant gave birth after using her previously cryopreserved oocytes in this project, so we have included her case report.

The purpose of this study was to conduct a survey of women who underwent social oocyte cryopreservation with government assistance, which was, to our knowledge, the first provided in the world at the time, to assess their opinions at the time they started it and 3 years later. The importance the participants' feelings on the significance of government assistance for cryofreezing was also considered.

## Methods

This prospective study was conducted with the support of a research grant from Urayasu city. As of April 1, 2015, when this research began, the population of Urayasu City was approximately 164,000, with a birth rate of 1.1 and about 10,000 women between the ages of 20 and 34. Participants were recruited from April 2015 to March 2018 from female residents of Urayasu city aged 35 years or younger. Further details are provided in our previous study,[16] but briefly, anyone living in Urayasu City could participate, and we solicited workshop participants through the city's public relations magazine and their website. As this project was started as a 3-year-only endowed course from the city, recruitment of applicants was limited to 3 years, and the subjects were those who were invited to participate during that period. The only exclusion criterion was if a doctor' s examination determined that the egg freezing procedure itself was dangerous. Every month, a seminar would be held in the city to increase awareness of childbirth, explain current oocyte retrieval methods and future pregnancy rates, and explain the research concept and risks. No oocyte retrieval and cryopreservation fees were charged to the participants for 3 years after the end of the project, but thereafter, they were responsible for the cryopreservation fees. The information provided in the seminar focused on the decrease in fertility with advancing age and explained forms of assisted reproductive techniques available within Japan, rather than explicitly recommending oocyte cryopreservation. After the seminar, the participants were also asked to participate in a fertility awareness survey.

The awareness survey was conducted via a questionnaire provided at the end of the 3-year project period. All 34 women who opted for cryopreservation responded to the survey. Participants were provided with options such as "yes" or "no" as responses, and we calculated the percentages of each response. Results are shown as the median, maximum, and minimum values. We also left a free text entry field for participants to enter their own responses.

We followed the STROBE guideline to ensure proper reporting of the study.

### *Statistical analysis*

In this study, the survey was conducted solely as a means to compile data on the thoughts and opinions of the participants, and no tests to determine significant difference were conducted.

## Results

### *Project course*

In total, 105 women participated in the lectures, including those who lived in surrounding areas. Along with those who relocated from other regions, 62 participants were municipal residents. Two participants quickly considered pregnancy after the explanatory lectures and became pregnant spontaneously. Ultimately, 34 participants underwent oocyte retrieval (mean age at procedure: 32.8 years, mean number of oocytes retrieved: 8.3). All participants who wanted to undergo egg freezing were able to do so, and no one was excluded. The reasons given for undergoing oocyte retrieval included both "social" reasons, such as planning a lifeline when an appropriate partner is found, or when career development is complete, or a lack of financial stability displayed by an existing partner or husband, and "iatrogenic" reasons, such as endometriosis and Turner syndrome that decrease ovarian function. A previous study[16] showed that most married women transitioned to regular assisted reproductive technology (ART) without postponing pregnancy. Only two women had their oocytes frozen. The husband of one of these women required testicular sperm extraction (TESE) due to his spinal cord injury, so because TESE could not be performed immediately, they wanted to freeze their oocytes first. The other woman had a mental illness and the relationship between the couple was unstable, so after we consulted with them, they finally concluded that they would like to freeze their oocytes, but they have not used their oocytes yet. However, none of the participants reported malignant tumors as a reason for cryopreservation. At the time the questionnaire was distributed, three women had become pregnant naturally, one of whom had given birth twice, and one became pregnant through partner insemination, and this same woman subsequently achieved natural pregnancy. Only one woman gave birth using frozen oocytes. At the time of writing, one additional woman had become pregnant and given birth naturally, and two had given birth through ART. As a result, 8 of the 34 women became pregnant and gave birth, resulting in 10 births (Table 1).

**Table 1.** Progress of the project participants at the end of the 3-year project and at 3 years later.

| Participant no. | Age at freezing (years) | Age at present (years) | First child | | Second child | | Total number of eggs | Stored MII | Stored MI | Stored GV |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 29 | 36 | | | | | 6 | 6 | 0 | 0 |
| 2 | 33 | 39 | 2020.1 | Natural pregnancy | | | 4 | 4 | 0 | 0 |
| 3 | 33 | 39 | | | | | 4 | 3 | 1 | 0 |
| 4 | 34 | 41 | 2020.9 | Natural pregnancy | — | — | 10 | 10 | 0 | 0 |
| 5 | 34 | 40 | — | — | — | — | 4 | 4 | 0 | 0 |
| 6 | 34 | 40 | | | | | 5 | 5 | 0 | 0 |
| 7 | 34 | 41 | | | | | 12 | 12 | 0 | 0 |
| 8 | 34 | 40 | | | | | 7 | 7 | 0 | 0 |
| 9 | 34 | 40 | 2021.12 | Natural pregnancy | — | | 6 | 4 | 2 | 0 |
| 10 | 34 | 40 | — | | — | | 17 | 17 | 0 | 0 |
| 11 | 34 | 41 | | | | | 11 | 6 | 5 | 0 |
| 12 | 34 | 41 | | | | | 10 | 10 | 0 | 0 |
| 13 | 34 | 40 | 2021.5 | Use of frozen eggs | — | | 7 | 7 | 0 | 0 |
| 14 | 32 | 39 | | | | | 11 | 9 | 1 | 1 |
| 15 | 34 | 40 | 2018.7 | Natural pregnancy | 2021.3 | Natural pregnancy | 6 | 5 | 1 | 0 |
| 16 | 31 | 37 | | | | | 22 | 22 | 0 | 0 |
| 17 | 34 | 40 | 2021.9 | ART | — | Considering using frozen eggs | 8 | 7 | 1 | 0 |
| 18 | 32 | 38 | — | | — | | 3 | 3 | 0 | 0 |
| 19 | 28 | 34 | — | | — | | 16 | 16 | 0 | 0 |
| 20 | 34 | 39 | 2019.8 | AIH | 2020.1 | Natural pregnancy | 9 | 4 | 2 | 3 |
| 21 | 34 | 40 | | | | | 8 | 8 | 0 | 0 |
| 22 | 30 | 35 | | | | | 3 | 3 | 0 | 0 |
| 23 | 32 | 37 | | | | | 6 | 6 | 0 | 0 |
| 24 | 34 | 40 | — | — | — | — | 13 | 13 | 0 | 0 |
| 25 | 32 | 37 | | | | | 2 | 2 | 0 | 0 |
| 26 | 34 | 39 | | | | | 4 | 4 | 0 | 0 |
| 27 | 33 | 38 | | | | | 5 | 5 | 0 | 0 |
| 28 | 33 | 38 | | | | | 10 | 10 | 0 | 0 |
| 29 | 34 | 39 | Unknown | ART | | | 14 | 14 | 0 | 0 |
| 30 | 30 | 35 | | | | | 6 | 6 | 0 | 0 |
| 31 | 31 | 38 | | | | | 3 | 3 | 0 | 0 |
| 32 | 34 | 39 | | | | | 7 | 7 | 0 | 0 |
| 33 | 33 | 38 | | | | | 7 | 7 | 0 | 0 |
| 34 | 32 | 36 | | | | | 15 | 15 | 0 | 0 |

AIH: artificial insemination with husband's semen; ART: assisted reproductive technologies; GV: germinal vesicles; MI: immature egg; MII: mature egg.

## *Questionnaire*

In total, 34 participants responded to the questionnaire. All participants responded "yes" to the question "Are you happy that you opted for oocyte cryopreservation?" In response to the question "Would you have opted for cryopreservation without the grant?," 23 participants (67.6%) responded "no," 9 participants (6.5%) responded "yes," and 2 participants responded that they did not know. The median response to the question "For those who are not currently pregnant, until when would you consider becoming pregnant?" was 39 (33–52) years. With regard to plans after cryopreservation, 25 participants (73.5%) responded that they would attempt to become pregnant spontaneously before using the oocytes, whereas 4 participants (11.8%) stated that they would use the oocytes first. These four

participants suffered from a variety of conditions, such as endometriosis, primary ovarian failure, and Turner syndrome, and one participant's husband had azoospermia. The remaining five participants (14.7%) were those mentioned above who became pregnant. When asked what they would do if they used the cryopreserved oocytes and still did not become pregnant, all responded that they would have no alternative but to accept that outcome at the time. To the question "Do you think this will be an effective strategy for combating the declining birthrate?," 21 participants (61.8%) responded "yes," giving reasons such as this intervention becoming a part of infertility treatment to raise social awareness, or the information being good for the participant's mental health. Ten participants (29.4%) responded that it would be indirectly effective because this strategy is an effective option if women receive financial support while they are young. Three subjects (8.8%) responded that it would be ineffective as the primary issue is the large gender gap in society. All participants, other than those who became pregnant, expressed a desire to continue paying for cryopreservation and were doing so. At the time of the survey, a further two participants requested to use their cryopreserved oocytes.

### *Pregnancy after oocyte thawing*

Here, we briefly describe the case in which pregnancy occurred using cryopreserved oocytes. To perform retrieval of oocytes for cryopreservation, we initiated ovarian stimulation from day 3 of the menstrual cycle using the short method. On day 11 of the cycle, when the ovarian follicle diameter and estrogen levels were adequate, meaning that the oocytes were considered mature, the participant was given 10,000 U of human chorionic gonadotrophin (hCG) and oocyte retrieval was performed. Seven oocytes were retrieved and cryopreserved at that time in 2016. The patient subsequently married and attempted to use the timing method and artificial insemination to become pregnant, but she could not remain so. In 2020, 3.5 years after the initial retrieval, we once again used the short method to perform ovarian stimulation but were only able to retrieve three oocytes. We thus simultaneously opted to perform in vitro fertilization (IVF) of both these and the previously cryopreserved oocytes.

Her anti-Müllerian hormone level at the time of initial oocyte cryopreservation was 1.06 ng/mL, but it had decreased to 0.58 ng/mL at the time of IVF 3.5 years later. After the administration of a total of 450 units of follicle stimulating hormone and 300 units of human menopausal gonadotropin, and triggering with 10,000 units of hCG, three oocytes were subsequently collected on the 12th day.

Before treatment, her husband's semen findings were volume, 1.5 mL; concentration, 49 million/mL; and motility rate; 37%, and after the swim-up technique was applied, IVF was performed with sperm at a concentration of 6 million/mL and motility rate of 100% that were collected on the same day as that of the three oocytes. Simultaneously with IVF, the frozen oocytes were also thawed and fertilized using intracytoplasmic sperm injection.

Following successful fertilization, a single blastocyst (grade BB) observed on day 5 was cryopreserved. The seven previously cryopreserved oocytes that had been thawed and undergone microscopic insemination yielded four blastocysts (two of grade BB, two of grade BC) on day 5, which were also cryopreserved. During a separate menstrual cycle, from day 3, the patient received hormone supplementation with Julina tablets (Bayer Yakuhin Ltd., Osaka, Japan), Estrana tapes (Hisamitsu Pharmaceutical Co., Saga, Japan), Duphaston tablets (VIATRIS Japan, Tokyo, Japan), and Lutinus vaginal tablets (Ferring Pharmaceuticals, Tokyo, Japan). After discussion with the patient, we implanted the single blastocyst (BB) attained from IVF on day 5. Pregnancy was confirmed on day 0 of gestational week (GW) 4 based on a serum level of β-hCG of 47.3 mIU/mL. Hormone supplementation continued until day 6 of GW 9, and the patient was transferred to antenatal care after an unremarkable clinical course. Noninvasive prenatal testing results were negative. There were no abnormalities during the course of her pregnancy, and the infant was delivered on day 1 of GW 38 by elective cesarean section. The infant's birthweight was 2,702 g, and Apgar scores were 8 and 9. No abnormalities of growth or development have been observed in the infant to date.

## Discussion

In this study, 34 women had their oocytes frozen, but only one subsequently gave birth using her oocytes. However, at the time of the questionnaire survey, four women had become pregnant naturally or by partner insemination without using oocytes. In the questionnaire survey, many women answered that they would like to try to conceive naturally without using oocytes, and as a result of participating in the workshop, four of them became pregnant naturally after thinking about their pregnancy in a "planned" manner. Thus, the major value of this initiative appeared to be the education of women about age-related decline so that they would try to become pregnant sooner, and this resulted in more babies by far than did oocyte cryopreservation. Another result of the survey was identification of the opinion that oocyte cryopreservation is not an effective measure to combat the declining birthrate as the gender gap has still not been eliminated. The decrease in pregnancy rates has become obvious due to societal aging, and if we look at a breakdown of a related study,[16] we see that there was one iatrogenic reason for cryopreservation unrelated to chemotherapy. As women continue to delay marriage and childbirth, we believe it is important to increase opportunities for these young women to ensure

oocyte preservation autonomously.[17] There are reports that the problem with oncofertility is the difference in access depending on the treatment environment due to a lack of collaboration between cancer-specialized facilities and infertility-specialized facilities.[18] However, when the present study was conducted, there was no financial support for oncofertility treatment, let alone for "social" oocyte cryopreservation, and for this reason, we also focused on researching the study participants' reasons for freezing their oocytes.

As society has continued to age over the past few years, women are increasingly opting to have a child under ideal circumstances at some point in the future. This concept of elective, "nonurgent" cryopreservation is new to Japan. Until now, we have considered two reasons for cryopreservation, iatrogenic and social. Instead, oocyte cryopreservation can also be seen as promoting the right to self-determination by the woman herself. The two reasons are practical—they offer women a way to plan in advance for future pregnancies, whether they choose to do so due to cancer therapy or to more urgent reasons, such as reproductive organ removal.[15,19] Instead of adopting a conventional and paternalistic approach, in which healthcare providers decide on the reasons for oocyte cryopreservation, the patients should give their consent after being adequately informed about the limitations and risks. However, it goes without saying that long-term follow-up studies are essential to determine the effects of these measures. Any explanation should include the facts that some aspects of treatment have not yet been fully clarified and that this in itself is a limitation at the present.[19] As a result of our municipal lectures on fertility in this study, two participants changed their life plan to suit their fertility and became pregnant spontaneously. We need to be able to definitively improve the current issue, which is the difficulty in obtaining education on fertility. However, there is only so much that individuals or municipalities can do—it is also important to improve sex education while holding informative seminars. We believe it may be possible as a social act to obtain a more complete society that does not primarily focus on infertility treatment and instead enables women to manage both their reproductive behavior and social activities. This will involve raising awareness of fertility for both men and women.

While it is ethically permissible to systematically cryopreserve oocytes in preparation for the decline in fertility that occurs with age,[20] it is also important to provide sufficient information for this purpose. During this study, we held regular briefing sessions and provided information that allowed the women and their partners to consider whether oocyte cryopreservation was necessary for them. The satisfaction level indicated by the survey results seems to reflect the sessions' effectiveness. Furthermore, with some of the costs being subsidized, we can now consider oocyte cryopreservation to be a viable option.

While oocyte cryopreservation has become an option for women to extend their reproductive years, it[21] may also potentially offer a countermeasure to the declining birthrate as reports[22] have suggested a poor balance between the cost, which changes depending on the number of oocytes preserved and on the facility, and the low frequency of use in terms of cryopreservation efficacy. Even within Japan, there are differences in price based on the number of oocytes retrieved, and the annual costs take a toll over time. If the costs for the drugs used until an oocyte is retrieved are included, then the total cost is approximately 300,000 yen. According to the National Tax Administration Agency, the September 2020 Statistical Survey of Actual Status for Salary in the Private Sector showed that the mean salary for men between 20 and 24 years of age was 2.77 million yen, with women in the same age group earning 2.42 million yen.[23] From 25 to 29 years of age, men earned 3.93 million yen and women earned 3.19 million yen, illustrating how the sex-related differences increase with age. However, the cost burden for cryopreservation that must be borne by this particular group of adolescents and young adults will be high. Although corporate industry, for example, companies such as Apple, does sometimes provide support, company welfare/benefit programs are only beneficial to the employees. However, to spread the burden over society as a whole, national and local governments can offer more effective financial support for many women (and not only working women). In the present study, however, a municipal grant paid approximately 200,000 yen that would have been borne by the participants and thus increased the social options for oocyte cryopreservation. If it is possible to obtain these grants in different areas around the country, this opportunity could be offered to a much larger number of people. A study from the UK reported that oocyte cryopreservation was carried out in 373 cases, after which the oocytes were thawed a mean period of 3.7 years later, resulting in 12 infants born to 11 women.[24] Pregnancy was achieved using donor sperm in one-third of the cases, leading to children born to single mothers, and this idea of women placing the priority on pregnancy over marriage is a new concept in Japan. However, the period in which the cryopreserved oocytes could be used was not very long, and this might mean that participants felt limited by the period in which the cryopreservation costs were covered.

Oocyte cryopreservation may offer a lifeline to women, and being able to adjust the deadline of 3 years after the end of the project would support many women in their life planning. However, we also believe that the presence of a deadline may motivate women to use the cryopreserved oocytes sooner. Costs of this project were covered by a 3-year donation of 30 million yen per year provided by Urayasu City. The overall effect of the project, which included not only egg freezing but also monthly workshops, was to encourage people to consider pregnancy

even without using egg freezing. In terms of cost effectiveness, the project as a whole resulted in 10 babies being born among the 34 participants, which can be said to be quite effective. Furthermore, as some participants are continuing to have their eggs frozen, further positive effects can be expected. Regarding the conclusion, we believe that although the effectiveness of egg freezing itself as a measure to combat the declining birthrate is still unclear, it seems that workshops for women who are considering conceiving in the future will empower women to become pregnant.

### Limitations

Limitations in this study included the fact that the project was subject to a deadline, that the study population was small, consisting only of 34 women, and that the validity and reliability of the questionnaire were not tested. Therefore, a power analysis to determine sample size could not be performed. As it was not possible to provide support for the project indefinitely, it was limited to a period of a few years. However, this is the first study of this kind, to our knowledge, to be conducted in which public funds were used for cryopreservation, and we will continue to see children born as a result of this project, which will be reported in time.

## Conclusion

Our study, which used oocyte cryopreservation as a countermeasure against the declining birthrate, showed that education and awareness programs targeting municipal citizens are highly effective and resulted in effects that at the very least supported the initial procedural costs. We believe that considering the reasons for cryopreservation to be either iatrogenic or social increases the risk of paternalism on the part of the healthcare staff. Social oocyte cryopreservation is a medical activity and as one method of providing women with additional reproductive options, it should only be performed based on the plans of the individual in question after the provision of accurate information on the procedure, drugs, risks, and benefits. It is essential for local municipalities to provide financial support to assist participants with the initial costs of cryopreservation, and we believe that this project shows the very best of the results that can be achieved.

## Declarations

### Ethics approval and consent to participate

This study was conducted in accordance with the Japanese Society for Reproductive Medicine's "Guidelines for Freezing and Preserving Unfertilized Eggs or Ovarian Tissues for Social Adaptation" (http://www.jsrm.or.jp/guideline-statem/guideline_2013_02.pdf). It was performed with the approval of the Ethics Committee of Juntendo Urayasu Hospital (Approval No. 30-001). Written informed consent to participate in this study was obtained from all study participants.

### Consent for publication

Written informed consent was obtained from all study participants, including the participant whose case was reported herein, to allow publication of their identifiable data.

### Author contribution(s)

Motoharu Ohno was in charge of writing the article and in vitro fertilization after oocyte thawing. Iwaho Kikuchi, Koyo Yoshida, and Shintaro Makino planned and supervised this research. Iwaho Kikuchi was the physician in charge of oocyte collection and also supported writing of the article. Noriko Kagawa conducted the questionnaire survey on cryopreservation and followed up on the course of the participants. Yuka Shirosaki and Ikumi Shinozaki assisted in cryopreservation and in vitro fertilization as culturists. Takuhiko Ichiyama and Motoharu Ohno were in charge of in vitro fertilization. Shintaro Makino supervised all pregnancy cases after oocyte thawing and delivering babies in the women with childbirth. All authors read and approved the final manuscript.

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### Competing interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Availability of data and materials

The raw data from the present research are available upon reasonable request from the corresponding author.

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## Supplemental material

Supplemental material for this article is available online.

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