Feasibility and effectiveness of preconception check-ups at workplaces in Japan

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Abstract

Objectives: Despite the recent increase in infertility and perinatal complications, preconception care is not commonly available in Japan. Working women are considered to have the greatest need for preconception care, as they increasingly marry and have children later in life. This study aimed to assess the feasibility and effectiveness of preconception check-ups in the workplace.

Methods: We provided 51 female employees aged 18–39 years with free preconception check-ups, including additional blood tests and an online medical questionnaire, during mandatory health check-ups at their workplace. A doctor provided online counselling based on the check-up results. We assessed fertility knowledge using the Cardiff Fertility Knowledge Scale (CFKS-J) and childbearing desire pre- and post-intervention.

Results: Preconception check-ups revealed various potential risk factors for future pregnancies, including underweight (12%), obesity (20%), *Chlamydia trachomatis* IgG antibody positivity (22%), low Rubella IgG antibody levels (47%), iron deficiency (12%), and 25-hydroxyvitamin D levels <30 ng/mL (98%). Post-intervention, the participants reported high satisfaction with the check-ups and significantly advanced their reproductive plans (P=0.008). Further, 95% of the participants indicated an intention to seek medical attention or make lifestyle changes. The post-intervention CFKS-J score (mean ± SD) was higher than the pre-intervention score (71.7 ± 19.3 versus 63.0 ± 22.0, P=0.006).

Conclusions: We developed a preconception check-up package that can be integrated into workplace health examinations, complemented by tailored counselling. This novel check-up package is a feasible and effective approach for improving preconception health and fertility awareness.

Keywords: feasibility studies, preconception care, reproductive health service, women's health

Key Points

What is already known on this topic

- With more women joining the labour force while pursuing reproductive goals, promoting their health, including preventing infertility, is important for occupational health.
- Preconception care can prevent infertility and perinatal complications, reduce health risks for future generations, and promote longevity.
- However, Japanese women are generally reluctant to visit clinics for gynaecological and reproductive health concerns, which undermines their chances of learning about preconception care and using it in their daily lives.

What this study adds

- To facilitate communication between reproductive-aged female workers and health professionals in Japan, we designed a free preconception check-up package for the workplace, integrating it with workplace health examinations, complemented by tailored counselling.
- This novel check-up package, supported by a local government, identified several pre-pregnancy health risks, including being underweight or obesity, being significantly malnourished, and not receiving sufficient gynaecological examinations. This check-up package warrants further attention in occupational health settings.
- Tailored preconception counselling based on blood tests and medical questionnaires improved the fertility knowledge of the participants.
- Participants reported high satisfaction with the package and significantly advanced their reproductive plans after the preconception checkup.

How this study might affect research, practice or policy

- Preconception check-ups for female employees during their annual workplace medical check-up removed barriers to preconception care such as cost, time constraints, and geographical access.
- This model could be an effective approach for promoting preconception care, resulting in improved health of female workers.

Introduction

The global trend of postponing parenthood has led to an increase in the prevalence of infertility[1] and various perinatal complications such as miscarriage, gestational diabetes, preeclampsia, labour dystocia, and caesarean deliveries.[2] In Japan, the need for infertility treatment is increasing, with 1 in 4.4 couples undergoing infertility testing or treatment,[3] causing 23% of women undergoing infertility treatment to leave the workforce.[4] Menstrual problems, such as irregular cycles, dysmenorrhoea, and heavy menstruation, not only lead to infertility but also cause an estimated annual productivity loss of 491.1 billion Japanese Yen (JPY; 3.3862 billion United States Dollars [USD]).[5] At the time of the study, 1 USD = 145 JPY. Promoting women's health care and preventing infertility are extremely important in occupational health.

Preconception care (PCC) could be an effective approach for addressing these increasing public health issues.[6] PCC can prevent infertility and perinatal complications and reduce health risks in future generations.[7] For example, a 10% decrease in pre-pregnancy body mass index (BMI) is associated with at least a 10% risk reduction in preeclampsia and gestational diabetes.[8] Daily folic acid supplementation before conception reduces the risk of neural tube defects by 70%.[9] Furthermore, considering a life-course approach, PCC can prevent non-communicable diseases and promote healthy longevity,[10] regardless of reproductive life plan.

In 2006, one recommendation by the Centers for Disease Control and Prevention (CDC) was to 'assure that all women of childbearing age in the United States receive preconception care services (i.e., evidence-based risk screening, health promotion, and interventions) that will enable them to enter pregnancy in optimal health.'[11] Despite the increased number of health problems PCC can prevent, most Japanese people remain unfamiliar with PCC;[12] moreover, fertility knowledge in the population is low.[13,14] An international survey showed that the level of fertility knowledge in Japan was the lowest among developed countries.[13] Japanese women are generally reluctant to visit clinics for gynaecological and reproductive health concerns, as evidenced by the fact that 3.0% use oral contraceptives.[15] Only 10% of the women reported having a family doctor who could treat gynaecological conditions,[16] which

undermined their chances of learning about PCC and using it in their daily lives. Additionally, universal health insurance in Japan covers diseases and treatments but not preventive care, including PCC. Presently, only a few clinics offer PCC as a private service and charge approximately 30,000–46,000 JPY (200–300 USD) per visit, making it unlikely for most people to become familiar with PCC.

Previous studies have shown that tailored education and counselling by health professionals are acceptable and effective for increasing fertility and PCC awareness.[17] To facilitate communication between people of reproductive age and health professionals in Japan, we designed a free preconception check-up package at workplaces by maximising the 'enabling factors' for health service use according to Andersen's Behavioural Model.[18] Andersen's Behavioural Model is a sociological framework used to predict and explain health service use. The model is designed to elucidate how an individual's use of health services is influenced by factors such as their characteristics, health status, and the external environment. [18] In this novel check-up package supported by a local government, we removed the barriers of cost, time constraints, and geographical access to PCC and provided female employees with free preconception check-ups and online counselling during mandatory workplace check-ups. This study aimed to evaluate the feasibility and effectiveness of this novel check-up package to promote PCC as an occupational health measure in Japan.

Methods

Participant recruitment and study procedure

The Occupational Safety and Health Act mandates annual health check-ups for regular employees in Japan. Therefore, employees receive free health check-ups at their workplaces or contracted healthcare facilities. Taking advantage of this statutory screening for employees, we developed a preconception check-up package that included additional blood tests for preconception health (e.g. serum folic acid), medical questionnaires, and individual online counselling by an obstetrician-gynaecologist (AF) based on the test results (Figure 1). A non-profit organisation, acting as a 'hub' between the employer, employees, and obstetrician-gynaecologist, was responsible for setting up and managing the preconception check-up package. This arrangement reduced the burden on employers and employees while protecting participants' privacy. Information regarding whether each employee applied for the program and details about test

results and counselling were kept confidential, with no disclosure to the company or its occupational health professionals. To evaluate the feasibility and effectiveness of the preconception check-up package, we conducted online surveys before and after the intervention.

We distributed a short brochure to employees at a welfare business and a hospital in Akita City. Only interested employees participated in this study. The inclusion criteria were female employees aged 18–39 years who underwent workplace health check-ups. Pregnant women were excluded from the study. All study procedures were conducted from 1 November 2022 to 16 March 2023. This study was supported by the Akita Prefecture's Technology Innovation Creation and Utilization Promotion Project [Industry-Academia-Government Collaboration Booster Project]; there was no cost burden for companies or individual participants.

T1: Pre-intervention survey

At T1, participants completed an online survey on sociodemographic characteristics, fertility knowledge, and childbearing desires.

Sociodemographic characteristics

We asked about age (in years), marital status (single, not married but partnered, or married), number of children (none, one, two, three, or more), working during night shifts (yes/no), working hours per week (<40 h or ≥40 h), and university education (yes/no). Additionally, we asked about annual household income, which was categorised as <4 million JPY (<27,533 USD), ≥4 million to <6 million JPY (≥27,533 to <41,300 USD), ≥6 million to <8 million JPY (≥41,300 to <55,066 USD), ≥8 million JPY (≥55,066 USD), or 'unknown'.

Fertility knowledge and childbearing desires

Participants completed the Japanese version of the Cardiff Fertility Knowledge Scale (CFKS-J).[13,14] To date, the CFKS, which has been translated into 12 languages and used in 18 countries, remains the only validated fertility knowledge scale. This scale consists of a 13-item questionnaire designed to investigate knowledge in three domains: indicators of reduced fertility, common misconceptions about fertility, and basic facts about infertility. All items were rated on a three-point scale of 'true', 'false', or 'do not know'; scores of zero and one point were assigned to an incorrect or 'do not know' answer and a correct answer,

174 respectively. Scores were reported as the percentage of the highest possible scores. The internal
175 consistency coefficient alpha among the participants was 0.80. Participants stated their desired number of
176 children/additional children and their plan to conceive ('I am currently trying to conceive', 'I will try to
177 conceive in a few months', 'I will try to conceive in one year', or 'I do not know yet'). For those with no
178 plan to conceive, we asked about the age at which they hoped to have their first or next child. For those
179 who planned to conceive within a year, we assumed the desired age to have the first/next child to be their
180 current age.
181 *Reasons for participating in this study*
182 To understand the feasibility of this novel preconception check-up package, we asked participants the
183 reason for participating in this study with options including 'because I want to know for the future',
184 'because I currently have problems with menstruation', 'because I currently have problems with
185 infertility', and other reasons given in free-text comments. Additionally, we asked prerequisite conditions
186 to receive preconception check-ups from the following options: 'additional blood sample at the annual
187 check-up', 'without visiting medical institutions', 'without the company knowing', 'online counselling by
188 an obstetrician/gynaecologist,' and other prerequisites provided by free-text comments.
189
190 ***T2: Preconception check-ups***
191 *Mandatory workplace health check-ups*
192 We obtained the following participants' information needed for PCC from the mandatory workplace
193 health check-ups: height, body weight, systolic and diastolic blood pressures, and blood tests, which
194 included haemoglobin (Hb; normal range,[19] 11.6–14.8 g/dL), HbA1c (4.6–6.2%), hepatic function tests
195 (i.e., aspartate aminotransferase [13–30 U/L], alanine transaminase [7–23 U/L], and gamma glutamyl
196 transferase [9–32 U/L]), and lipid profile (i.e., triglyceride [30–149 mg/dL], low-density lipoprotein
197 cholesterol [60–139 mg/dL], and high-density lipoprotein cholesterol [40–96 mg/dL]). We evaluated the
198 blood test results according to the Health Guidance Assessment Values established by the Ministry of
199 Health, Labour and Welfare.
200 *Additional blood tests*
201 We performed the following blood tests along with workplace examinations, according to
202 recommendations[20] and previous studies, while considering cost and feasibility. The blood tests (normal

range) included tests for serum iron (40–188 μg/dL),[19] serum ferritin (<12 ng/mL),[21] serum zinc (≥80 μg/dL),[22] serum folate (≥7.0 ng/mL),[23] and serum 25-hydroxyvitamin D (25(OH)D; ≥ 30 ng/mL) tests,[24] thyroid function (i.e., thyroid stimulating hormone [0.35–4.9 μIU/mL], free triiodothyronine [1.71–3.71 pg/mL], and free thyroxine [0.70–1.48 ng/dL]), *Chlamydia trachomatis* (*C. trachomatis*) immunoglobulin (Ig) antibodies (i.e., IgG and IgA; negative), syphilis (i.e., rapid plasma reagin [RPR] and treponema pallidum haemagglutination [TPHA] tests; negative), and rubella IgG enzyme immunoassay (≥8 IU/mL).[25]

Medical questionnaires

For tailored preconception counselling, we asked participants about their lifestyle, medical history, and reproductive history using an online medical questionnaire. Regarding lifestyle, participants reported their and their partners' smoking status (yes, former, or never), alcohol consumption (<3 or ≥3 times per week), and current use of folic acid supplementation (yes/no).

We asked them about their history of chronic diseases (e.g. hyperthyroidism, hypothyroidism, diabetes, and mental disorders), number of pregnancies and deliveries, and infertility experience (yes/no). For menstruation, we assessed the regularity and length of the participants' menstrual cycle and the amount of menstrual bleeding (light, moderate, or heavy). We assessed the severity of dysmenorrhoea using the Dysmenorrhoea Score, the Use of Analgesics Score, and level of pain on a numerical rating scale (0–10).[26] The Dysmenorrhoea Score is based on the degree of work limitation during the last menstruation, rated as none, mild (i.e. some loss of work or study efficiency), moderate (i.e. needing to rest in bed and/or loss of work), or severe (i.e. ≥1 day in bed). The Analgesics Score is rated based on the number of days participants used analgesics during the last menstruation, with the following ratings: none, mild (taking analgesics for 1 day), moderate (taking analgesics for 2 days), or severe (taking analgesics for 3 or more days). Additionally, we checked whether they had undergone an annual or biennial cervical smear test.

Online counselling

Counselling was conducted individually by an obstetrician-gynaecologist (AF). Sessions were primarily conducted via Zoom (video calls). Alternatively, the session was conducted either via telephone or face to face. Following the guidelines of the CDC[6] and the Royal Australian and New Zealand College of

Obstetricians and Gynaecologists,[20] counselling was provided on the impact of the following factors on infertility, perinatal complications, and child health: age, body shape (BMI), blood pressure, anaemia, malnutrition (iron, vitamin D, zinc, and folate), and rubella IgG antibodies. It was not possible to make a diagnosis by examining the data used in this study; therefore, explanations were provided from a screening perspective.

We provided information on menstruation-related symptoms, problems (menorrhagia, dysmenorrhoea, and premenstrual syndrome), and management strategies; techniques for timing, if they planned to conceive; and appropriate contraception methods if they did not want to conceive based on their previous or current contraceptive methods (oral contraceptives, intrauterine devices or systems, condoms, rhythm method, withdrawal, emergency contraception, and none). After the counselling session, a document detailing the content of the counselling session was enclosed with the test results and sent to the participants' homes.

T3: Post-intervention survey

We asked the participants to respond to the following items immediately after the counselling sessions: CFKS-J, the number of children desired in the future, the desired age of the first/next child, and their plan to conceive. We asked about satisfaction with and recommendations for counselling on a 5-point Likert scale. Participants reported their feelings of security after counselling (feel relieved, feel neither, or feel anxious), their intentions to change their behaviour after counselling (visit a gynaecologist, improvement in lifestyle, no future changes in behaviour, or free text comments), and changes in their reproductive life plan (finding a partner sooner, getting married sooner, getting pregnant sooner, having no effect, or free text comments).

Statistical analyses

We described the distribution of the sociodemographic background, lifestyle, and medical and reproductive histories of the study participants. Additionally, we described the reasons for study participation and T3 feedback from the participants. We compared CFKS-J scores at T1 and T3 using paired t-tests to assess post-intervention changes in fertility knowledge and childbearing desire. Wilcoxon signed-rank tests and paired t-tests were used to compare changes in childbearing desires. All analyses

were performed using STATA14-MP (StataCorp LP, USA).

Results

Overall, 51 women (26 from a welfare business and 25 from a hospital) participated in the study and completed the T1 survey and preconception check-up. The participation rate was 22% (26/117) in the former, but unknown in the latter because not all employees were informed about the study. Of the 51 participants, 44 received preconception counselling. Finally, 41 participants responded to the T3 survey (Supporting Information 1).

Study population

Table 1 shows the sociodemographic characteristics of 51 participants. The median age was 29 years (interquartile range [IQR]: 26–32 years). Approximately half were in the middle-income group (≥ 4 and < 8 million JPY), and 45% had university education. Approximately one-third of the participants were single and the rest were in a relationship. The largest proportion of respondents (65%) had no children.

The reasons for participating in the study were as follows: 78% wanted to know about the future, 18% participated because of current menstrual problems, 12% participated because of current infertility problems, and 6% had tried to conceive. Prerequisites for preconception check-ups included additional blood tests at annual check-ups (90%), without visiting medical institutions (39%), without the company's knowledge (24%), and online counselling by a gynaecologist (12%).

Medical and reproductive histories and lifestyle

Table 2 shows the medical and reproductive histories and lifestyles of the study participants. While 12% of the participants were current smokers, >20% had partners who smoked. Less than 20% of the patients were taking folic acid supplements.

A total of 12 (24%) patients had a history of chronic diseases, including thyroid dysfunction and diabetes, and six (12%) had received infertility treatments. The most common method of contraception was condom use (86%), whereas only 12 (27%) used oral contraceptives.

A significant proportion of the participants had menstrual problems, with over 40% having irregular cycles. Eleven (22%) participants had moderate to severe dysmenorrhoea, and 16 (31%) reported moderate or severe analgesic use. The median (IQR) menstrual pain score on the numerical rating scale was 4 (2–7). Less than half of the patients underwent annual or biennial cervical smears.

Results from preconception check-ups

Nearly 70% maintained a healthy weight, whereas about 10% were underweight (BMI <18.5 kg/m^2) and 20% were overweight (BMI 25–29.9 kg/m^2) or obese (BMI ≥30 kg/m^2) (Table 3). Although only a small proportion of the participants presented with abnormal lipid profiles or hepatic function; 16% of the participants had hypertension. Anaemia (haemoglobin <12 g/dL) and iron deficiency (ferritin < 12.0 ng/mL) were present in four (7.8%) and nine (17.6%) participants, respectively.[21]

None of the patients tested positive for syphilis. One in five patients was suspected to have previous or current chlamydia infection. Approximately half of the patients had rubella IgG antibody levels below the level required to prevent congenital rubella syndrome. Only one participant had vitamin D sufficiency, and 42 (82%) had vitamin D deficiency (serum 25(OH)D <20 ng/mL).[24] Only half of the participants had serum folate >7.0 ng/mL, which is the level required before pregnancy to prevent neural tube defects in the foetus.[23]

Post-intervention (T3) survey

Figure 2 shows the T1–T3 changes in fertility knowledge and childbearing desires among the 41 participants in the T3 survey. The mean ± SD score for the CFKS-J improved significantly from 63.0±22.0 to 71.7±19.3 percentage points (P=0.006, Figure 2a). However, no significant changes were observed in the desired number of children/additional children (P=0.77, Figure 2b). Excluding those who did not want children and those who answered ‘unknown’, the desired age for the first/next child was similar (31.3±3.6 at T1 and 31.1±3.7 at T3; P=0.30; paired t-test). However, the participants significantly advanced their reproductive life plans; the number of participants trying to conceive doubled post-intervention (P=0.008, Figure 2c).

Table 4 shows the post-counselling feedback from 41 study participants. Participants' satisfaction was extremely high, and most wanted to recommend the preconception check-up to others. The majority of participants felt relieved rather than anxious after counselling. Moreover, preconception check-ups had an impact on future behaviour. More than 40% planned to attend an obstetrics and gynaecology clinic. Almost 80% planned to improve their lifestyle. More than half of them planned to speed up their reproductive life by finding a partner or moving their marriage or pregnancy plans forward.

Discussion

We designed a preconception diagnostic package integrated with workplace health exams, complemented by tailored counselling. Our findings suggest that this model is highly effective in enhancing fertility awareness, motivating lifestyle changes, and expediting reproductive life planning. This approach will help promote gender equality and women's active participation in the workforce and address infertility issues, which are prevalent in the field of occupational health in Japan. We also identified several pre-pregnancy health risks, including relatively high proportions of underweight and obesity, significant malnutrition (notably vitamin D and folic acid deficiencies), and low rates of gynaecological examinations, that warrant further attention in occupational health settings. While this study's short-term nature did not allow for the assessment of enhancements in preconception health or pregnancy outcomes, future extended follow-ups will elucidate the benefits of such check-ups on participants' health.

Our preconception check-up package (Figure 1) satisfied the participants' needs. Apart from the advantage of integrating the checks into occupational health checks, many participants highlighted convenience and confidentiality as key incentives of the check-up package (Table 1). With more women in the workforce, promoting PCC in occupational settings is essential, although uncommon because of privacy concerns. Our approach, integrating a neutral mediator between employer, employee, and clinician, addressed these barriers. Aligning PCC with regular health checks makes it more accessible to employees. To our knowledge, this is the first PCC promotion study in an occupational context.

Tailored PCC counselling based on blood tests and medical questionnaires notably improved fertility knowledge, as indicated by an increase from 63.0±22.0 to 71.7±19.3 percentage points on the CFKS-J.

While the increase was not substantial compared with when comprehensive information was provided,[27] our tailored approach neither induced anxiety nor reassured participants (Table 4), aligning with a previous tailored study[17,28] and contrasting with uniform ones.[27] Our data further suggest that imparting medical insights, like age-related fertility decline, can influence reproductive planning. While the desire for childbirth remained consistent, more women aimed for near-future conception (Figure 2c). A previous study indicated an advanced actual childbearing timing in the Japanese population.[29] Hence, long-term follow-ups are essential to assess if reproductive plan changes reduce infertility or perinatal issues.

Preventing sexually transmitted infections and ensuring proper immunisation are vital for reducing infertility and mother-to-child infections. This study revealed that about one in five women had a *history of C. trachomatis infection*. *C. trachomatis* targets specific epithelial cells, causing cervicitis with often mild or no symptoms. However, some may develop pelvic inflammatory disease, leading to complications such as ectopic pregnancy and infertility.[30] Chlamydia infections have increased since 2015, especially among those in their 20s.[31] The Japanese survey, based on 1000 medical centres, could not determine the total infection cases. This marks the first report of Chlamydia antibody prevalence in Japan's general population.

Secondly, rubella antibody titre and vaccination are essential. Rubella can cause congenital rubella syndrome in pregnant women, leading to hearing loss, cardiac issues, and visual disturbances. The World Health Organization advocates pre-pregnancy rubella vaccination to prevent congenital rubella syndrome and limit rubella spread.[32] Despite Akita City (study location) offering subsidised rubella tests and vaccinations, most participants were unaware of rubella infections during counselling. There is a clear knowledge gap in Japan regarding pregnancy-related infectious diseases, necessitating increased awareness.

This study found that many women experienced menstrual issues, such as irregular cycles, dysmenorrhoea, and hypermenorrhoea. Addressing this is pivotal for women's success and health and for countering declining birth rates. In our pre-intervention survey, 18% of respondents reported menstrual

abnormalities, and most had not sought care from a gynaecologist. After the intervention, participants became aware of their menstrual issues, with 42% indicating plans to visit the hospital. Since menstrual-related productivity loss has a huge impact on society,[5] especially in settings where more women join the labour force, visiting clinics and receiving appropriate treatments would not only improve preconception health but also benefit employment.

In our study, 32% of the participants had an inappropriate weight: 12% were underweight and 20% were obese. Being underweight can increase the risk of low birth weight (LBW) infants due to undernutrition.[8,33] Obesity, which increases the likelihood of preeclampsia and premature birth, also escalates the risk of LBW. Despite Japan's low infant mortality rate, its LBW rate surpasses that of other regions in East Asia and the Pacific.[34] Initiatives like Health Japan 21 and Healthy Parents and Children 21 aim to address this by reducing LBW and underweight among the youth, and weight gain targets during pregnancy have been revised.[35,36] However, the increase in LBW infants has not yet decreased. During mandatory health check-ups, women outside the ideal weight range often receive generic advice, excluding preconception health. Online counselling about the impact of weight on pregnancy may better inform and influence women's behaviours.

In this study, the nutrient levels in the blood, which are not available in normal workplace health check-ups, increased the awareness of participants' potential health risks. Data on the serum concentrations of nutrients and trace elements in young Japanese non-pregnant women are scarce. The data from this study are extremely useful for promoting preconception care suitable for Japanese women. Particularly, low serum folate and vitamin D deficiencies were observed among women. Folate intake in Japan has been declining annually, with a small number of supplement recipients.[37] Folate is not only linked to the prevention of foetal neural tube defects,[25] but, along with other nutrients, it is also associated with pregnancy.[38] As folate intake in the Japanese population is declining and is particularly low among young people, folic acid supplementation should be promoted. Furthermore, serum 25(OH)D levels were below the reference level in nearly all participants, suggesting the need for increased vitamin D intake. This may be partly because this study was conducted in Akita Prefecture. Akita Prefecture is located at 39 °N and has one of the shortest daylight hours in Japan. Winter (November to March), the season in which this

study was conducted, was particularly short, with less than 100 hours of sunlight per month. The average temperature during the study period was approximately 0–10 °C, and the study area has snowfall. Factors such as season, region, and ultraviolet radiation exposure play roles in these levels.[39] Vitamin D receptors are prevalent in the reproductive system, including the ovaries and endometrium.[40] Although the vitamin D-fertility link is debated, sufficient levels are associated with higher clinical pregnancies and births. The roles of vitamin D and folate were emphasised in counselling, and participants with deficiencies were advised on dietary considerations. Subsequent follow-up evaluations will be conducted to determine the behavioural impact of these health assessments.

To expand our preconception check-up project and implement it in society, we must consider the costs, payer of these costs, and information management. This study was a high-cost project that provided online counselling to all participants. To make it sustainable in the future, it will be necessary to reduce the burden and cost for professionals who provide individual counselling. Selecting only women at high risk who require individual counselling or developing automated digital communication, such as an AI-based chatbot, may reduce costs. Our approach, which includes a neutral mediator between the employer, employee, and clinician, is feasible from an information management perspective. This study was funded by the local government as a research project. However, in the future, employers could be another payer, as in the case of cervical cancer screening as an optional test at a medical institution that conducts annual health check-ups or mass influenza vaccinations at the workplace. For example, mass workplace influenza vaccination could reduce time costs and improve vaccine uptake[41], thereby benefiting employers, employees, and society[42]. Preconception check-ups supported by employers, together with the government, can be a promising future model.

This study had several limitations. First, the generalisability of our findings may be limited by the small sample size and the self-selection bias of including only women who were interested in the project; a study with a larger number of participants is currently underway, which will provide a more detailed understanding of the health issues faced by working women. In addition, as a future direction, it would be crucial to include people who are not interested in PCC. Second, in evaluating the effects after the

intervention, we could only confirm the intention to change behaviour. In future research, we plan to conduct follow-up surveys of the participants to assess their actual behavioural changes, such as dietary habits, exercise routines, and medical consultations, in detail. Finally, this was a feasibility study, and we could only perform one-armed pre-post comparisons. Larger studies with larger control groups are warranted in the future.

Conclusion

In this study, we provided preconception check-ups for female employees during their annual workplace medical check-ups. This novel check-up removed barriers to PCC, such as cost, time constraints, and geographical access. This study demonstrated that the preconception check-up model is feasible and effective for promoting PCC. We plan to evaluate the long-term effects of this model on participants' preconception and perinatal health, which will add to the importance of this novel project in the near future.

Acknowledgements

We thank Prof. Jacky Boivin (Cardiff University), Dr. Osamu Hiraike (Department of Obstetrics and Gynecology, The University of Tokyo Hospital), Mr. Shiro Yamasaki (Special Advisor to the Cabinet, Japan), and Prof. Tadashi Kimura (Department of Obstetrics and Gynecology, Osaka University Graduate School of Medicine) for their expert advice. This study was supported by the Akita Prefecture Technology Innovation Creation and Utilisation Promotion Project–The Industry–Academic Government Collaboration Booster Project.

Author contributions

Author contributions: A.F., E.M. and K.S. conceived the ideas; K.S. and C.O. collected the data; E.M. analysed the data; H.S. and Y.T. provided comments and conceptual advice; and A.F. and E.M. led the writing.

Supplementary data

Supplementary Information 1: Participant flowchart

Approval of the research protocol

This study was approved by the Ethics Board of the Akita University Graduate School of Medicine and Faculty of Medicine (approval number: 2872).

Informed Consent

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and its latest amendments. Written informed consent was obtained from all patients for being included in the study.

Animal Studies

N/A.

Conflict of Interest

Authors declare no Conflict of Interests for this article.

Study Funding

This study was supported by the Akita Prefecture Technology Innovation Creation and Utilisation Promotion Project–The Industry–Academic Government Collaboration Booster Project.

Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

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603 **Tables**

604 Table 1 Sociodemographic characteristics and T1 feedback of 51 participants

605

	N (%) or median (IQR)	
Sociodemographic characteristics		
Age	29	(26–32)
Marital status		
Single	16	(31.4)
Not married but partnered	12	(23.5)
Married	23	(45.1)
Number of children		
None	33	(64.7)
One	8	(15.7)
Two or more	10	(19.6)
Night-shift	16	(31.4)
Working hours per week		
<40 hours	16	(31.4)
≥40 hours	35	(68.6)
University education	23	(45.1)
Annual household income		
<4 million JPY	9	(17.6)
≥4 and <6 million JPY	13	(25.5)
≥6 and <8 million JPY	12	(23.5)
≥8 million JPY	8	(15.7)
Unknown	9	(17.6)
Cues for promotion of preconception care		
Reasons to participate in this study		
Because I want to know for the future	40	(78.4)
Because I currently have problems with menstruation	9	(17.6)
Because I currently have problems with infertility	6	(11.8)
To start trying to conceive (free-text comments)	3	(5.9)
Prerequisites for preconception check-ups		
Additional blood tests at the annual check-up	46	(90.2)
Without visiting medical institutions	20	(39.2)
Without the company knowing	12	(23.5)
Online counselling by an obstetrician/gynaecologist	6	(11.8)

606 Abbreviations: IQR, interquartile range; JPY, Japanese Yen

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608 Table 2 Medical and reproductive histories and lifestyle of 51 participants

	N (%) or median (IQR)	
Lifestyles		
Smoking		
Current smokers	6	(11.8)
Partner's smoking, yes	12	(23.5)
Habitual drinker (≥3 times per week)	7	(14.0)
Folic acid supplementation, yes	10	(19.6)
Medical and reproductive history		
Chronic disease, yes	12	(23.5)
Nulligravida	32	(62.7)
Nulliparity	33	(64.7)
Experience of infertility treatments	6	(11.8)
Contraception, ever used †		
Oral contraceptives	12	(27.3)
IUS/IUD	0	(0.0)
Condom	38	(86.4)
Rhythm methods	11	(25.0)
Withdrawal	20	(45.5)
Emergency contraception	4	(9.1)
Menstruation		
Age of menarche (median, IQR)	12	(11–13)
Regularity		
Regular cycles	30	(58.8)
Cycle length (days)	29.5	(28–30)
Irregular cycles	21	(41.2)
Amount of menstrual bleeding		
Light	1	(2.0)
Modest	45	(88.2)
Heavy	5	(9.8)
Dysmenorrhea score‡		
None	16	(31.4)
Mild	24	(47.1)
Moderate	7	(13.7)
Severe	4	(7.8)
Analgesics score‡		
None	22	(43.1)
Mild	13	(25.5)
Moderate	12	(23.5)
Severe	4	(7.8)
Pain on Numerical Rating Scale (0–10)	4	(2–7)
Annual or biennial cervical smear tests (yes)	22	(43.1)

609 †N = 44, because we asked contraceptive methods during online counselling.

610 ‡The Dysmenorrhea and Analgesics scores are grouped according to a previous study.[26]

611 Abbreviations: IQR, Interquartile range; IUS/IUD, Intrauterine system/Intrauterine device.

612 Table 3 Results from mandatory and additional health check-up data of 51 study participants

	N (%) or median (IQR)	
Body mass index (kg/m^2)[§]		
Underweight (BMI<18.5)	6	12.0%
Normal (BMI 18.5–24.9)	34	68.0%
Overweight (BMI 25–29.9)	5	10.0%
Obese (BMI≥30)	5	10.0%
Blood pressure[¶]		
Normal	33	64.7%
Elevated	10	19.6%
Hypertension stage 1	5	9.8%
Hypertension stage 2	3	5.9%
Blood tests		
Haemoglobin (g/dL, median, IQR)	13.4	(12.6–14.0)
<12.0 g/dL (N, %)[†]	4	7.8%
Serum iron	102	(71–123)
<40 μg/dL (N, %)	3	5.9%
Ferritin (ng/mL, median, IQR)	30.9	(15.4–53.3)
<12.0 ng/mL (N, %)	9	17.6%
HbA1c (%, median, IQR)	5.0	(4.9–5.3)
≥5.6% (N, %)[†]	3	5.9%
Triglyceride (mg/dL)	68	(53–90)
≥150 mg/dL (N, %)[†]	3	5.9%
LDL cholesterol (mg/dL)	105	(95–122)
≥120 mg/dL (N, %)[†]	14	27.5%
HDL cholesterol (mg/dL)	71	(57–84)
≤39 mg/dL (N, %)[†]	0	0.0%
AST (IU/L)	17	(16–20)
≥31 IU/L (N, %)[†]	2	3.9%
ALT (IU/L)	13	(11–18)
≥31IU/L (N, %)[†]	4	7.8%
GGT (IU/L)	15	(12–19)
≥51 IU/L (N, %)[†]	1	2.0%
Serologic tests for syphilis: TPHA-positive or RPR-positive	0	0.0%
Chlamydia trachomatis IgA antibodies-positive	5	9.8%
Chlamydia trachomatis IgG antibodies-positive	11	21.6%
Rubella IgG antibodies <8.0 IU/mL (EIA)	24	47.1%
25-hydroxyvitamin D (ng/mL)	12.4	(9.2–17.5)
<20 ng/mL	42	82.4%
20.0–29.9 ng/mL	8	15.7%
≥30.0 ng/mL	1	2.0%
Serum zinc (μg/dL)	94	(86–99)
<60 μg/dL	0	0.0%
≥60 to <80 μg/dL	9	17.6%
≥80 μg/dL	42	82.4%
Serum folate (ng/mL)	7.2	(6.1–10.6)
<4.0 ng/mL	2	3.9%
≥4.0 to <7.0 ng/mL	21	41.2%
≥7.0 ng/mL	28	54.9%
Thyroid Stimulating Hormone (μIU/mL)	1.47	(1–1.81)
<0.35 μIU/mL	1	2.0%
≥4.94 μIU/mL	0	0.0%

§There was one missing data.
¶Blood pressure was classified into three categories (normal blood pressure: systolic blood pressure [sBP] < 120 mmHg and diastolic reading [dBP] < 80 mmHg). Elevated blood pressure: sBP 120–129 mmHg and dBP < 80 mmHg. Stage 1 hypertension: sBP 130–139 mmHg or dBP 80–89 mmHg. Stage 2 hypertension: sBP ≥ 140 mmHg or dBP ≥ 90 mmHg)
Abbreviations: IQR, Interquartile range; BMI, body mass index; HbA1c, Haemoglobin A1c; LDL, Low Density Lipoprotein; HDL, High Density Lipoprotein; AST, aspartate aminotransferase; ALT, alanine transaminase; GGT, gamma glutamyl transferase; TPHA, treponema pallidum haemagglutination; RPR, rapid plasma reagin; EIA, enzyme-immunoassay.
†Cut-off values are based on the health guidance judgment values of the standard health check-up and health guidance programme established by the Ministry of Health, Labour and Welfare.

647 Table 4 Results on counselling satisfaction and behaviour change (n=41)
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	N	(%)
Are you satisfied with the counselling?		
Strongly agree	30	(73.2)
Strongly agree	11	(26.8)
Neither agree nor disagree	0	(0.0)
Disagree a little	0	(0.0)
Strongly disagree	0	(0.0)
Would you like to recommend the preconception check-up to others?		
Strongly agree	27	(65.9)
Agree a little	12	(29.3)
Neither agree nor disagree	2	(4.9)
Disagree a little	0	(0.0)
Strongly disagree	0	(0.0)
A sense of security after counselling		
Relieved	35	(85.4)
Neither	4	(9.8)
Anxious	2	(4.9)
Intention to change health behaviour after counselling		
See an obstetrician/gynaecologist	17	(41.5)
Improve your lifestyle	32	(78.0)
No change in future actions	2	(4.9)
Free text comments		
Take a folic acid supplement	2	(4.9)
Get rubella vaccine	1	(2.4)
Changes in the reproductive life plan		
Finding a partner sooner	4	(9.8)
Getting married sooner	5	(12.2)
Getting pregnant sooner	13	(31.7)
Having no effect	19	(46.3)

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Figure legends

Figure 1: Collaborative framework of the preconception check-up package managed by a non-profit organisation

The figure depicts the flow of the preconception check-ups. 1) Non-profit organisation (NPO) provides information to the company and its employees; 2) those wishing to participate apply directly to the NPO and 3) complete a questionnaire; 4) the NPO coordinates the schedule with the medical examination provider; 5) participants undergo preconception check-ups at the same time as the staff medical examination; 6) the results of the medical examination are sent directly to Akita University; 7) the NPO shares the data of the examinees, including the questionnaire contents, with Akita University; and 8) Akita University conducts online counselling based on the medical examination and questionnaire results.

Abbreviation: NPO, Non-profit organisation.

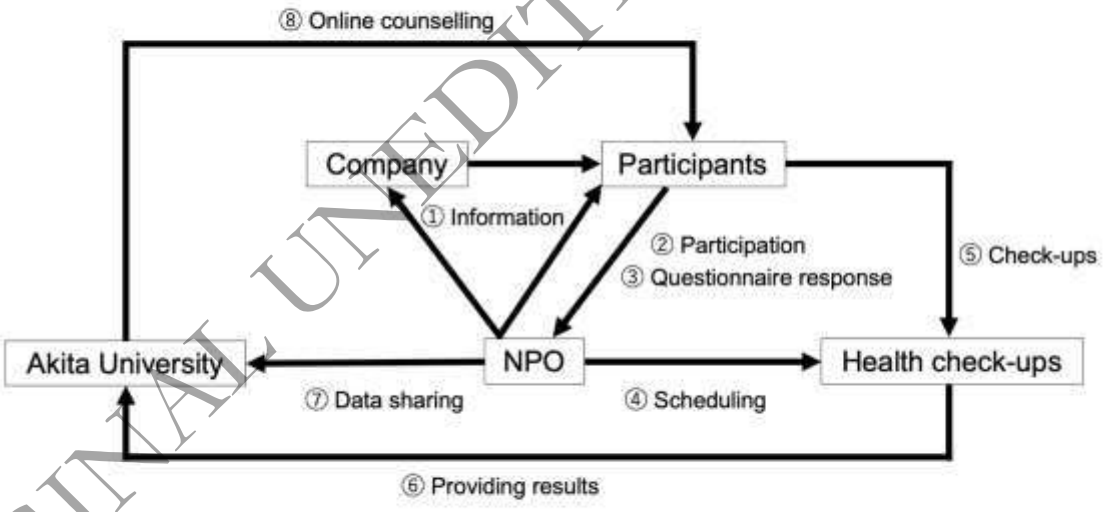

Figure 2: T1-T3 changes in fertility knowledge and childbearing desires (n = 41)

(a) Comparison of the Japanese version of the Cardiff Fertility Knowledge Scale (CFKS-J) scores pre- and post-intervention

Pre- and post-intervention mean (95% confidence interval) scores on the CFKS-J are shown. The preconception check-up package intervention significantly improved the score from 63.0 (56.1–70.0) to 71.7 (65.6–77.8) percentage points (P = 0.006, paired t-tests).

(b) Desired number of additional children

Pre- and post-intervention distributions are shown and compared using the Wilcoxon signed rank test.

(c) Plan to try conceiving

Pre- and post-intervention distributions are shown and compared using the Wilcoxon signed rank test. Those who desired ≥1 child were included (*n* = 32).