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ARTICLE

Reproductive outcomes after oocyte banking for fertility preservation

BIOGRAPHY

Eva Balkenende attended medical school at the Academic Medical Centre Amsterdam for University of Amsterdam. She is currently a PhD student at the Centre for Reproductive Medicine, Department of Obstetrics and Gynaecology, at the Academic medical Centre in Amsterdam' for Amsterdam UMC. Her research interest includes fertility preservation in women.

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KEY MESSAGE

Three-quarters of women with stored oocytes who reported a pregnancy conceived naturally. Future research should focus on the factors that must be considered when deciding on oocyte banking, taking into account personal circumstances and expectations and the utility of banked oocytes. This would help women to make informed decisions about tailored fertility preservation.

ABSTRACT

Research question: What are the reproductive outcomes of women who bank oocytes for fertility preservation?

Design: A prospective follow-up study of a cohort of 327 women who banked their oocytes for fertility preservation was carried out between July 2009 and August 2015. The indications for oocyte banking and outcomes of ovarian stimulation were collected from medical files. Follow-up data were obtained from an additional questionnaire.

Results: In total, 243 out of 327 women (74%) responded and 228 women (70%) consented to participate and returned the questionnaire. The median time to follow-up of these women was 31 months. A total of 101 women (44%) were trying, or had tried, to become pregnant after oocyte banking, of which 66 became pregnant (65%). Five women reported an unintended pregnancy. Of these, 71 women became pregnant, 76% conceived naturally, 7% through intracytoplasmic sperm injection with their vitrified–warmed oocytes and 17% by other medically assisted reproduction treatments. Six women attempted to achieve a pregnancy using their banked oocytes. Of the six pregnancies achieved in five women, two resulted in a live birth. A total of thirty-eight women reported a live birth at the time of follow-up.

Conclusion: : Oocyte banking can be considered a form of risk management or preventive medicine because it is not certain that the women will experience sterility in the future.

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KEYWORDS
Fertility preservation
Follow-up
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Reproductive outcomes

INTRODUCTION

Guidelines issued by the American Society of Clinical Oncology, the International Society for Fertility Preservation and the American Society for Reproductive Medicine recommend discussing fertility preservation with women who have cancer or other medical conditions, which could possibly leading to premature ovarian insufficiency (POI) (*ASRM, 2013; Loren et al., 2013; Martinez, 2017; Oktay et al., 2018*). The European Society of Human Reproduction and Embryology has concluded that oocyte banking should not just be available for women at risk of premature pathogenic or iatrogenic fertility loss, but also for those who want to protect their reproductive potential against the threat of time (*Dondorp et al., 2012*). No consensus has been reached on the terminology for this indication; 'non-medical', 'anticipated gamete exhaustion' and 'age-related fertility decline' are all commonly used terms (*Stoop et al., 2014; Shenfield et al., 2017*). The European Society of Human Reproduction and Embryology recommends providing women with personalized and evidence-based information. It also suggests that centres offering the technique have a responsibility to contribute to the collection of long-term follow-up of children (*Dondorp et al., 2012*).

All women who bank oocytes for fertility preservation wish to preserve their chances of a future pregnancy with their own gametes (*Dondorp et al., 2012*). Oocyte banking can, therefore, be considered as a form of risk management or preventive medicine because it is not certain that women will experience premature ovarian insufficiency in the future (*Stoop et al., 2014*). Women who bank oocytes for age-related fertility decline have extra time to find a suitable partner to start a family, whereas, women who bank their oocytes before gonadotoxic treatment are providing their own 'fertility back-up' in case they become sterile after cancer treatment.

Utilization rates of banked oocytes are unknown and may differ between women with different indications for fertility preservation. To adequately counsel women before their decision to bank their oocytes, women are entitled to receive up-to-date information on the likeliness that they will actually make use of their banked oocytes in the future. Follow-up of women who banked oocytes for age-related fertility decline has been reported, but the number of women included is low and the follow-up time is short (*Baldwin et al., 2015; Stoop et al., 2015*). Also, in some studies, the number of women who attempted pregnancy after oocyte banking has not been reported, which makes the interpretation of pregnancy rates difficult (*Hodes-Wertz et al., 2013; Hammarberg et al., 2017a, b*). The reproductive follow-up of women who banked their oocytes before cancer treatment has only been described for women who returned to the clinic to actually use their banked oocytes or embryos (*Martinez et al., 2014; Oktay et al. 2015; Alvarez and Ramanathan, 2016*). Recently an Australian cohort reported the reproductive outcomes of men and women who banked reproductive material before cancer treatment, although only 39.5% of women responded and participated in this survey (*Hammarberg et al., 2017a, b*).

Most studies do not systematically address follow-up of women who bank oocytes as they do not report the number of women who attempt to conceive and on the number of women who conceive naturally. The aim of the present study was, therefore, to evaluate the reproductive status and outcomes of a large cohort of women who banked oocytes for fertility preservation.

MATERIALS AND METHODS

Participants

A cohort of women who banked their oocytes for fertility preservation was assembled at the Center for Reproductive Medicine at the Academic Medical Center, Amsterdam, the Netherlands. Oocyte banking with the vitrification technique started in 2006, and systematic collection of follow-up data started in 2009. A first report of 86 women who banked oocytes between 2009 and 2012 for medical indications was published in 2014 (*Dahhan et al., 2014*). For the present study, all 327 women who started ovarian stimulation for oocyte banking between July 2009 and August 2015 were included.

Data collection

Data on the indications for oocyte banking and outcomes of ovarian stimulation were extracted from medical files. A questionnaire, based on existing literature and the clinical experience of the investigators, was developed. Four topics were covered: demographics at time of follow-up; gonadotoxic treatment received after oocyte banking; attempts to conceive and pregnancies after oocyte banking; and intended plan for their banked oocytes. The questions consisted of multiple choice answers and free-text comments. The Dutch Municipal Personal Records Database system was used to verify addresses. The coded questionnaire was accompanied by an invitation letter with information leaflet and a pre-paid envelope, and was posted to participants between April 2015 and November 2016. At the time of follow-up, 15 months had elapsed since oocytes had been retrieved. Non-responders were telephoned 2 weeks after the questionnaire had been sent out, and another questionnaire was sent 4 weeks later. Women who had been invited to participate in 2013 were invited again for an extended follow-up (Dahhan, 2014).

Statistical analysis

SPSS 24 (IBM) was used to analyse data. Descriptive statistics were used for demographics at time of oocyte banking, indications for banking, outcomes of ovarian stimulation, demographics at time of follow-up, gonadotoxic treatment after oocyte banking, reproductive status and pregnancy outcomes after oocyte banking and intended plan for residual or banked oocytes. $P < 0.05$ was used to indicate statistical significance. Mann–Whitney U-test was used for continuous variables without normal distribution. Chi-squared test was used to determine the difference between two proportions.

Ethics committee approval

The Institutional Review Board of the Academic Medical Centre Amsterdam (project no W15_041) stated, on 11 February 2015, that the study was not subject to the Dutch 'Medical Research Involving Human Subjects Act', meaning that no further medical ethical approval was required.

RESULTS

Participant characteristics

Recruitment of the study cohort is shown in FIGURE 1. Questionnaires were sent to 327 women; 243 women (74%) responded and 228 women (70%) consented to participate and returned

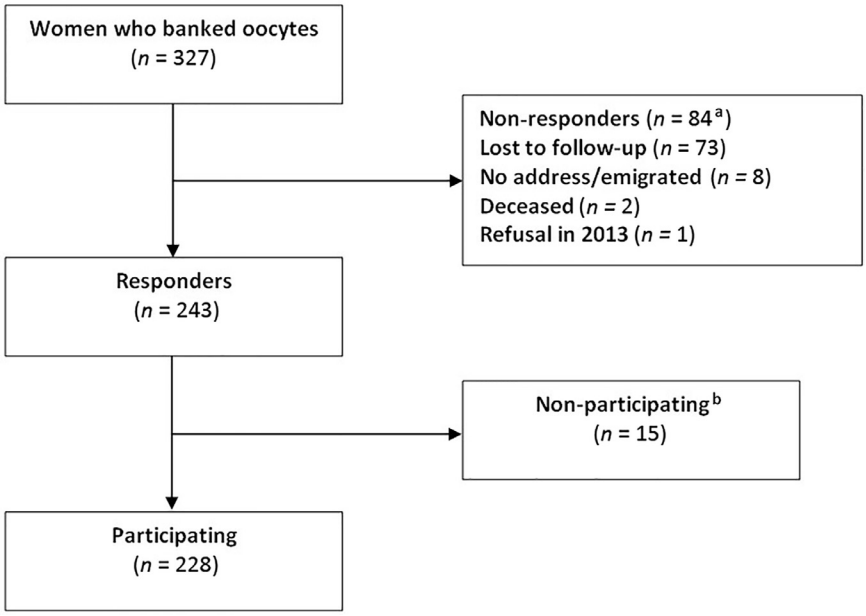

FIGURE 1 Study cohort of women who banked oocytes from July 2009 to August 2015.
[a+b]Grouped together as non-participants.

the questionnaire. Demographics at time of banking and outcomes of ovarian stimulation are shown in TABLE 1. No significant differences between participants and non-participants were found. Median age of participating women at the time of oocyte banking was 34.9 years (interquartile range 30.1–37.1) and 60 women (28%) were in a relationship at the time of oocyte banking. Participants underwent a total of 433 cycles of ovarian stimulation and the median number of cycles per women was two (interquartile range 1–3). The median number of banked oocytes per woman was 14 (interquartile range 8–23). Demographics and outcomes of ovarian stimulation in participating women subdivided by indication for oocyte banking are presented in **Supplementary TABLE 1.**

Indications for oocyte banking

Indications for oocyte banking were age-related fertility decline in 100 women (44%), scheduled gonadotoxic treatment in 89 (39%), other risks of POI in 20 (9%), and prior treatment, such as chemotherapy or ovarian surgery in 19 (8%). Participant demographics at time of follow-up are presented in TABLE 2. Mean age of women at time of follow-up was 37.5 years (interquartile range 32.9–39.5). Women who banked oocytes for other risks of POI had the longest follow-up (median, 39.5 months) and women who banked oocytes for age-related fertility decline had the shortest follow-up time since oocyte banking (median, 28.0 months).

TABLE 1 DEMOGRAPHICS AT THE TIME OF OOCYTE BANKING AND OUTCOMES OF OVARIAN STIMULATION

Characteristic	Participants n = 228	Non-participants n = 99
Median age at first oocyte retrieval in years (IQR)	34.9 (30.1–37.1)	34.8 (28.3–37.6)
In a relationship[a]	60 (28%) 15 missing	28 (31%) 9 missing
Parity, n (%)		
Nulliparous	216 (95)	94 (95)
One child	11 (5)	4 (4)
Two children	1 (0)	1 (1)
Median BMI (IQR)	21.7 (20.5–23.7) 15 missing	21.5 (20.1–24.4) 9 missing
Median number of cycles per patient (IQR)	2.0 (1–3)	2.0 (1–3)
Cycles cancelled, n (%)	29/433 (7)	12/197 (6)
Low response, n (%)	24 (83)	10 (83)
Antral follicle count (median, IQR)	11.0 (8–16) 16 missing	10.0 (6–14) 8 missing
Oocytes banked (median, IQR)	14.0 (8–23)	16.0 (5–25)

BMI, body mass index; IQR, interquartile range

No statistically significant differences between the two groups.

[a] Including one lesbian relationship.

TABLE 2 DEMOGRAPHICS AT TIME OF FOLLOW-UP OF PARTICIPATING WOMEN SUBDIVIDED BY INDICATION

Characteristic	All participants (n = 228)	Age –related fertility decline (n = 100)	Scheduled gonadotoxic treatment (n = 89)	Other risks of POI (n = 20)	Previous treatment (n = 19)
Median age in years (IQR)	37.5	39.1	33.8	32.4	32.6
	(32.9–39.5)	(37.9–40.8)	(31–37.5)	(25.9–34.7)	(29.5–39.3)
Median time to follow-up in months (IQR)	31.0	28.0	33.0	39.5	34.0
	(25–42)	(23–32)	(25–47)	(31.5–46.8)	(27–42)
In a relationship	139 (62%)[a]	50 (51%)[a]	60 (68%)	13 (65%)	16 (84%)
	2 missing	1 missing	1 missing		
Higher education level (≥ pre-university or university), n (%)	193 (85)	94 (94)	65 (73)	17 (85)	17 (89)
Median BMI at follow-up kg/m2 (IQR)	22.3	22.2	22.7	22.4	22.0
	(20.6–24.4)	(20.6–24.1)	(20.7–25.7)	(21.0–24.3)	(20.1–23.9)
	4 missing	1 missing	3 missing		

BMI, body mass index; IQR, interquartile range; POI, premature ovarian insufficiency.

[a] Including one lesbian relationship.

Actual gonadotoxic treatment after oocyte banking

At time of follow-up, 81 out of the 89 women (91%) who banked oocytes before gonadotoxic treatment had received gonadotoxic treatment (chemotherapy or pelvic radiation). Eight women did not receive chemotherapy. In four of these women, chemotherapy was cancelled, three of them had a benign disease for which chemotherapy was no longer necessary and one woman received adjuvant endocrine therapy after a low-risk MammaPrint (genetic breast cancer recurrence test). Pelvic radiation was cancelled in one woman after favourable pathology results. One woman only received adjuvant endocrine treatment for breast cancer. One woman was a BRCA mutation carrier and had a preventive oophorectomy after oocyte banking and one woman could not tell whether she received gonadotoxic treatment. Of the 80 women who received chemotherapy, 41 women reported the use of additional adjuvant endocrine therapy with tamoxifen or letrozole and 31 women reported that endocrine therapy was ongoing at time of follow-up. Two women underwent pelvic radiation in addition to their chemotherapy. Seven women also underwent pelvic surgery; four women had a unilateral oophorectomy (two women banked ovarian tissue); one woman had bilateral oophorectomy; one woman had an ovariopexy; and one woman underwent a radical hysterectomy.

Age-related fertility decline

One woman who banked her oocytes for age-related fertility decline reported a unilateral oophorectomy for ovarian cancer after oocyte banking.

Reproduction after oocyte banking

Reproductive status after oocyte banking of all women and in subgroups according to indication is presented in TABLE 3. Mode of conception and pregnancy outcomes in women who achieved pregnancy are presented in TABLE 4. One-hundred-and-one women (44%) attempted conception after oocyte banking. Sixty-six of these women (65%) reported at least one pregnancy after oocyte banking. Five of the 127 women (4%) who did not attempt conception reported an unplanned pregnancy after oocyte banking. A total of 71 women reported a pregnancy after oocyte banking of whom 76% conceived naturally, 7% conceived by intracytoplasmic sperm injection (ICSI) with their vitrified–warmed oocytes and 17% conceived with medical assistance, without the use of their banked oocytes. Thirty-eight women reported at least one live birth after oocyte banking. Thirty-four women were attempting conception at time of follow-up and one women was discouraged to continue further pregnancy attempts by her physician because of ovarian cancer. Of the 34 women, five (15%) were undergoing ICSI with their banked oocytes and one women tried to become pregnant with donor oocytes after using her own banked oocytes without success. Pregnancy outcomes are presented in TABLE 4. The 91 pregnancies resulted in 41 (45%) live births and 19 ongoing pregnancies (21%) at time of questionnaire completion. Specific details about the six women who used their banked oocytes are presented in TABLE 5. Of the six pregnancies achieved in five women, two resulted in a live birth.

Intended use and future destination oocytes

A total of 211 women (93%) still had oocytes banked at time of follow-up, the remaining 17 women (7%) had already used their oocytes or were not able to bank oocytes. Most women (*n* = 133 [63%]) who still had oocytes banked reported that they would use their oocytes if they had difficulties conceiving naturally and in case of residual oocytes 96 women (45%) did not yet have a specific destination for their oocytes. The intentions for future use and destination of residual oocytes subdivided by specific indication are presented in TABLE 6.

DISCUSSION

In our cohort of 327 women who banked oocytes for fertility preservation, most women banked their oocytes because of age-related fertility decline or scheduled gonadotoxic treatment. Almost one-half of women reported that they had attempted to conceive after oocyte banking at a median follow-up of 31 months. Three-quarters of the 71 women who reported a pregnancy, conceived naturally.

TABLE 3 REPRODUCTIVE STATUS FOR WOMEN WHO BANKED OOCYTES SUBDIVIDED BY INDICATION

Characteristic	All respondents (*n* = 228)	Age-related fertility decline (*n* = 100)	Scheduled gonadotoxic treatment (*n* = 89)	Other risks of POI	Previous treatment (*n*=19)
Attempted conception since oocyte banking					
Yes, n (%)	101 (44)	51 (51)	26 (29)	12 (60)	12 (63)
No, n (%)	94 (41)	29 (29)	52 (58)	7 (35)	6 (32)
No wish to conceive, n	70	29	29	7	5
Undergoing cancer Treatment, n	24	–	23	–	1
Other, n (%)[a]	33 (14)	20 (20)	11 (12)	1 (5)	1 (5)
Women with at least one pregnancy after oocyte banking, n (% of women who tried to conceive)	66 (65)	31 (61)	16 (62)	10 (83)	9 (75)
Women with unintentional pregnancies, n	5	2	3	–	–
All women with at least one pregnancy after oocyte banking, n	71	33	19	10	9
Method of conceiving					
Naturally conceived, n (%)[b]	54 (76)	26 (79)	15 (79)	8 (80)	5 (56)
Other medically assisted Reproduction, n (%)[c]	12 (17)	4 (12)	2 (11)	2 (20)	4 (44)
ICSI with banked oocytes, n (%)	5 (7)	3 (9)	2 (11)	–	–
Women with at least one live birth after oocyte banking, n	38	18	7	7	6
Currently trying to conceive (without a pregnancy so far), n	34	19	10	2	3
Natural conception, n (%)	13 (38)	3 (16)	7 (70)	2 (100)	1 (33)
Other medically assisted reproduction, n (%)	16 (47)	14 (74)	1 (10)	–	1 (33)
Artificial insemination with donor sperm, n	6	6	–	–	–
IUI, n	5 (2 with DST)	4 (2 with DST)	1	–	–
IVF–ICSI, n	2	1	–	–	1
Insemination at home	2	2	–	–	–
Oocyte donation[d]	1	1	–	–	–
ICSI with banked oocytes, n (%)	5 (15)	2 (11)	2 (20)	–	1 (33)
Further pregnancy attempts were discouraged	1	1	–	–	–

DST, donor sperm treatment, ICSI, intracytoplasmic sperm injection; IUI, intrauterine insemination; POI, premature ovarian insufficiency.

[a] Other reasons why women did not try to conceive: did not have a partner (*n* = 10); experienced an unintended pregnancy (*n* = 4); were physically or mentally recovering (*n* = 4), did not have an (functioning) uterus (*n* = 3); wanted to try to conceive in the next few months (*n* = 3), had a partner without child wish (*n* = 2); terminal stage cancer (*n* = 1); not yet tried conceiving (*n* = 1); were advised to wait 3 years because of cancer (*n* = 1); did not bank oocytes and no cycle (*n* = 1); were looking for co-parents (*n* = 1); had a future child wish (*n* = 1); or existent co-morbidity (*n* = 1).

[b] One women had one naturally conceived pregnancy and after this two pregnancies after oocyte donation.

[c] Two women had a pregnancy conceived with other medically assisted reproduction and after this their second pregnancy was natural conceived.

[d] Followed unsuccessful attempt using banked oocytes.

The strength of this study is that we repeated the systematic follow-up of a cohort of women who banked oocytes for fertility preservation. Also, a high participation rate of 80% was achieved in our first follow-up study and 70% in the present study (*Dahhan et al., 2014*).

Some limitations also warrant discussion. First, our results could be influenced by selection bias, as women who became pregnant might be more willing to return the questionnaire than women who did not manage to conceive, did not want to be confronted with their sterility or women who were still searching for the right partner with which to start a family. Second, the questionnaire was self-reporting and we were unable to check the answers of the participants. Third, we did not

TABLE 4 PREGNANCY OUTCOMES OF WOMEN AFTER OOCYTE BANKING SUBDIVIDED BY INDICATION

Characteristic	All respondents (n = 228)	Age-related fertility decline (n = 100)	Scheduled gonadotoxic treatment (n = 89)	Other risks of POI (n = 20)	Previous treatment (n = 19)
Total number of pregnancies	91	44	24	13	10
Naturally conceived, n (%)	70 (77)	34 (77)	20 (83)	11 (85)	5 (50)
Other medically assisted reproduction, n (%)	15 (17)	6 (14)	2 (8)	2 (15)	5 (50)
IVF–ICSI[a]	7 (1 DST)	2	2	–	3 (1 DST)
IUI	3 (1 DST)	1 (1 DST)	–	2	–
Oocyte donation	2	2	–	–	–
Ovulation induction	1	–	–	–	1
Artificial insemination with donor sperm	1	–	–	–	1
Insemination at home	1	1	–	–	–
ICSI with banked oocytes, n (%)	6 (7) (1 DST)	4 (9) (1 DST)	2 (8)	–	–
Pregnancy outcomes, n (%)					
Live birth	41 (45)	19 (43)	7 (29)	7 (54)	8 (80)
Ongoing pregnancy at time of follow-up	19 (21)	9 (20)	6 (25)	4 (31)	–
Miscarriage	26 (29)	13 (30)	9 (38)	2 (15)	2 (20)
Induced abortion[b]	3 (3)	1 (2)	2 (8)	–	–
Termination of pregnancy[c]	1 (1)	1 (2)	–	–	–
Ectopic pregnancy	1 (1)	1 (2)	–	–	–

DST, donor sperm treatment.

[a] Using fresh oocytes.

[b] Induced abortion: requested by the woman because of unwanted pregnancy.

[c] Termination of pregnancy: requested by the woman because of a chromosomal abnormality.

use a validated questionnaire, but developed the questionnaire ourselves based on published research and the clinical and research experience of the authors. Fourth, we did not ask why one-half of the women did not attempt to conceive. Our high response and participation rate is comparable with other follow-up studies after fertility preservation (*Schmidt et al., 2013; Stoop et al., 2015; Hammarberg et al., 2017a*). Compared with a recently published Australian cohort study of cancer patients, our response rate is higher (*Hammarberg et al., 2017b*).

The natural conception rate in women who banked oocytes for age-related fertility decline in our study is high compared with other studies (*Stoop et al., 2015; Hammarberg et al., 2017a*). In the present study, more than one-half of women who banked oocytes before scheduled gonadotoxic treatment and tried to become pregnant naturally afterwards, actually became pregnant. These results are comparable with the findings of an Australian cohort study in cancer patients (*Hammarberg et al., 2017b*). Reports of other studies are difficult to compare as these studies only reported on women who banked oocytes before gonadotoxic treatment and returned to use their banked oocytes; data on natural conception are, therefore, missing (*Martinez et al., 2014; Oktay et al., 2015; Alvarez and Ramanathan, 2016*). This is an important oversight, as follow-up of women who banked ovarian tissue before gonadotoxic treatment has shown that more than 76–90% of the reported pregnancies were naturally conceived and only few women had used their banked ovarian tissue (*Schmidt et al., 2013; Lotz et al., 2016*).

The actual use of banked oocytes was limited; however, of the 101 women who tried to conceive since oocyte banking, 11 women (11%) reported using their banked oocytes or were in the process of using their banked oocytes. Five women reported that they conceived after ICSI with their banked oocytes. Also, five women reported they were trying to conceive with their banked oocytes and one women with donor oocytes after using her own banked oocytes without success at the time of follow-up. Because the denominator of women who had tried to conceive naturally since oocyte banking is lacking in other studies, we are not able to compare this finding with other studies (*Hodes-Wertz et al., 2013; Hammarberg et al., 2017b*). The usage rate in the present study based on the number of participating women as denominator was 5% (11/228). Although this was similar to the rate of 6% in a US study (*Hodes-Wertz et al., 2013*), it cannot be directly compared, as the present study included both women who banked their oocytes for age-related fertility decline and those who were scheduled for gonadotoxic treatment, whereas the study by *Hodes-Wertz et al. (2013)* only inlcuded women who banked their oocytes for age-related fertility decline. Nevertheless, this is in the same order as in men who banked sperm for fertility preservation in whom the use of cryopreserved semen is 8% (*Ferrari et al., 2016*). Beside the utility of banked oocytes, women also had other assisted reproductive treatments and even fresh IVF or ICSI treatments. The self-reporting nature of the questionnaire precluded us from finding out why women opted for

TABLE 5 CHARACTERISTICS AND REPRODUCTIVE OUTCOMES OF WOMEN WHO USED THEIR BANKED OOCYTES

Participant	1	2	3	4	5	6
Age at storage (years)	37	38	26	39	37	38
Relationship status at time of banking	Single	Relationship (lesbian)	Relationship	Relationship	Single	Single
Indication for oocyte banking	Gonadotoxic treatment	Age-related fertility decline	Gonadotoxic treatment	Age-related fertility decline	Age-related fertility decline	Age-related fertility decline
Number of cycles of ovarian stimulation	4	2	1	2	1	2
Number of oocytes vitrified	11	30	10	25	5	2
Age at warming (years)	41	40	28	41	39	40
Number of oocytes warmed	11	17	10	8	5	2
Survival rate, n (%)	9 (82)	16 (94)	6 (60)	8 (100)	5 (100)	2 (100)
Embryo development	Yes, 4 embryos	Yes, 4 embryos	Yes, 1 embryo	Yes, 4 embryos	Yes, 1 embryo	No
Embryo transfers	3[a] (including 2 cryo-embryo transfers[b])	3 (including 2 cryo-embryo transfers[b])	1	4 (including 3 cryo-embryos[b])	1	–
Pregnancy	Yes	Yes	Yes	Yes, 2 pregnancies	Yes	No
Miscarriage	Yes	Yes	Yes	Yes	No	No
Live birth	No	No	No	Yes	Yes	No
Oocytes stored	No	Yes 13 oocytes and 1 cryo- embryo left	No	Yes, 17	No	No
Other reported ART treatments after usage of oocytes	No	No	No	No	No	Oocyte donation

ART, assisted reproductive technology.

[a] One embryo did not survive thawing.

[b] In case of surplus embryos, embryos were cryopreserved with slow freezing and subsequently thawed in an embryo transfer cycle.

TABLE 6 INTENTION FOR USE OF OOCYTES SUBDIVIDED BY INDICATION.

	All women n = 228)	Age-related fertility decline (n = 100)	Scheduled gonad-otoxic treatment (n = 89)	Other risks of POI (n = 20)	Previous treatment (n = 19)
Oocytes banked at time of follow-up, n (%)	211 (93)	88 (88)	85 (96)	19 (95)	19 (100)
Future use of oocytes, n (%)					
Yes, if I won't be able to conceive naturally	133 (63)	55 (63)	53 (62)	12 (63)	13 (68)
I don't know	53 (25)	23 (26)	20 (24)	6 (32)	4 (21)
Other	17 (8)	8 (9)	7 (8)	–	2 (11)
No, I won't use them for myself	7 (3)	2 (2)	4 (5)	1 (5)	–
Missing	1 (0.5)	–	1 (1)	–	–
Destination of residual oocytes, n (%)					
I don't know	96 (45)	42 (48)	39 (46)	8 (42)	7 (37)
Research	53 (25)	19 (22)	22 (26)	7 (37)	5 (26)
Other women	28 (13)	14 (16)	7 (8)	2 (11)	5 (26)
Research or other women	22 (10)	10 (11)	11 (13)	1 (5)	–
Destroy	11 (5)	3 (3)	5 (6)	1 (5)	2 (11)
Missing	1 (0.5)	–	1 (1)	–	–

POI, premature ovarian insufficiency.

other assisted reproductive technology treatments instead of using their banked oocytes. The use of other assisted reproductive technology treatments instead of using banked oocytes is an interesting finding and future research should focus on the decision-making of women who become subfertile after oocyte banking.

Only one-half of the women who banked oocytes for age-related fertility decline had a partner at the time of follow-up. We know from earlier research that 'lack of a partner' is one of the main indications for women who face age-related fertility decline to bank their oocytes (*Hodes-Wertz et al., 2013; Stoop et al. 2015; de Groot et al. 2016*). Some women bank oocytes to have more time to find the right partner before deciding on single motherhood with donor sperm treatment. In our study, only a few of the women who banked oocytes for age-related fertility decline conceived with the use of donor sperm. At time of follow-up, however, on average 31 months later, eight of the 19 women were trying to conceive with the use of donor sperm.

The costs of three cycles of oocyte banking are reimbursed in the Netherlands if they are conducted for a medical condition. Women who bank oocytes for age-related fertility decline must pay for the treatment themselves. The costs for one cycle of ovarian stimulation and oocyte banking are approximately 3000–4000 euros. For age-related fertility decline, women must decide if they are financially capable of undergoing one or more cycles. They must consider if they have the means to invest in their own 'fertility back-up' and bank oocytes. For age-related fertility decline, a Markov model demonstrated that oocyte banking was cost-effective compared with IVF at older age if 61% of women would return to use their oocytes (*van Loendersloot et al., 2011*). Another mathematical model found that oocyte banking was cost-effective in women younger than 38 years and if at least 49% of the women would return to use their oocytes (*Devine et al., 2015*). We would like to point out that cost-effectiveness is not a relevant outcome, as these women desire natural conception and only use their banked oocytes in case of sterility.

Our results emphasize that oocyte banking represents a form of risk management: on the one hand, an a-priori unknown risk of absolute sterility and on the other hand the possibility that banked oocytes are unnecessary. This non-committal concept should be discussed during counselling, especially for those women whose treatment is not reimbursed by their healthcare insurance. During counselling of women who wish to bank oocytes for age-related fertility decline, the option of single motherhood with donor sperm treatment needs to be discussed. Follow-up data on pregnancies, births and the actual use of oocytes should be integrated into clinical work-ups. Future research should focus on the considerations women have when deciding on oocyte banking, taking into account personal circumstances and individual life expectations. Such data could improve informed decision making and individualization of fertility preservation options.

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.rbmo.2018.07.005.

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