Female oncofertility attitude and knowledge: a survey of reproductive health professionals in Shanghai, China

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Aim: To evaluate the female oncofertility attitude and knowledge of reproductive health professionals in China. **Methods:** An online survey was distributed to reproductive health professionals in Shanghai, China. **Results:** Female professionals were more likely to consider that cancer patients would want to preserve their fertility. Participants with higher educational background tended to have a more positive attitude toward oncofertility. The majority of the participants (71.0%) obtained a fair or low level of oncofertility knowledge, and only 25.3% of them received scores at the 'good knowledge' level. **Conclusion:** There are significant gaps in the current oncofertility knowledge among reproductive health professionals in China, suggesting an urgent, unmet need for establishing an interdisciplinary fertility preservation training and service system.

First draft submitted: 5 June 2018; Accepted for publication: 21 September 2018; Published online: 8 January 2019

Keywords: cancer therapy • female oncofertility • infertility

With the remarkable advance of early cancer diagnosis and treatment strategy, there has been a substantial increase in the number of cancer survivors, allowing many patients to live long and productive lives after treatment. Now, there are more concerns regarding the side effects from cancer therapy as well as its impact on patient's quality of life. Fertility impairment is one of the major concerns targeted in female cancer patients because both chemotherapy and radiation have a well-documented history of causing damages to reproductive organs and increasing the risk of ovarian failure, early menopause and infertility [1].

To find a balanced solution between 'saving life' and 'saving fertility', there have been numerous efforts devoted toward preserving patients' fertility before and during cancer therapy. The co-treatment of gonadotropin-releasing hormone (GnRH) agonist with chemotherapeutic chemicals has been found to protect female cancer patients from chemotherapy-induced irreversible ovarian damage in 1990s [2]. Later, a new discipline called oncofertility was developed by Woodruff and her team in 2006 [3]. By integrating the efforts of oncologists, reproductive specialists and research scientists, oncofertility primarily focuses on providing adolescent and young adult cancer patients with fertility preservation options [4]. With respect to reproductive-aged women, oocyte and embryo cryopreservation are now the most common methods, and for prepubescent girls or those have no mature oocytes available, ovarian tissue or immature oocytes cryopreservation has also been explored [5,6]. Countries in North America and Europe now

have guidelines for providers on how to inform patients on steps they can take to preserve their fertility. For example, the American Society for Reproductive Medicine and European Society for Medical Oncology recommend that oncologists inform reproductive-aged cancer patients of the risks of infertility and refer them to fertility specialists for a fertility preservation consultation and therapy [7–9]. In Asia, the Fertility Preservation Society has been founded in several countries including Japan, India and Korea. In 2017, Japan published their first oncofertility guideline targeting children, adolescents and young adults with cancer [10].

China has the largest population of cancer patients in the world, accounting for 47.6% of all cancer cases in Asia and 22% worldwide [11]. The 5-year cancer survival rate has been increased from 30.9% in 2003 to 36.9% in 2015 [12]. In 2015, it was estimated that there were >1.7 million new female cancer patients in China and 15.0% of them are under 45 years of age, indicating a large number of individuals who will desire to seek pregnancy and childbirth after cancer [12,13]. To raise public awareness and promote professionals' practice of cancer therapy-induced infertility and fertility preservation, the Chinese Fertility Preservation Society was initiated in 2017 [14]. Although the assisted reproductive technology of oocyte/embryo cryopreservation has been developed in China for 30 years for infertility treatment, there are no specific clinical regulations or guidelines regarding preserving cancer patients' fertility. Moreover, the cryopreservation of oocytes or embryos is not available for unmarried women and the oocyte donation and surrogacy are not allowed by law in China [15]. These facts suggest that many prepubescent and reproductive-aged female cancer patients in China will receive chemotherapy and/or radiation without discussing possible reproductive damage and options of fertility preservation.

Reproductive health professionals including obstetricians, gynecologists and fertility specialists play important roles in oncofertility practice, including communicating with oncologists, providing professional advice regarding female patients' infertility risk, helping patients choose a fertility preservation option, and providing fertility preservation services. Therefore, the objective of this study was to evaluate the female oncofertility attitude and knowledge of reproductive health professionals in China.

Materials & methods

Questionnaire design

An online questionnaire was designed to evaluate reproductive health professionals' attitude and knowledge regarding cancer therapy-induced female infertility and fertility preservation in Shanghai, one of the major cancer and reproductive healthcare regions in China. The questionnaire was designed in English and was then translated into Mandarin prior to distribution. There were 32 questions which are listed in [Supplementary Table 1](#). The first ten questions collected participants' demographic information including gender, age, educational background, marital status, number of children, city/province, hospital level, specialty and years of working experience. According to the official classification system of Chinese hospitals, the hospital levels were categorized as 'level 3-A', 'level 3-B', 'level 2-A' and 'level 2-B and below'. The participants' oncofertility experience and attitude were recorded from questions 11 to 20. The last 12 questions were designed based on a previous study, which evaluated subjects' fertility preservation knowledge, and were modified to reflect the regulations and guideline in China [16].

Questionnaire distribution & data collection

The questionnaire was distributed via WeChat, a Chinese social media platform, between 20 August and 30 September in 2017. The link of the questionnaire was first sent to the Chief Directors of Obstetrics and Gynecology (OBGYN) departments in five major hospitals in Shanghai, China. More subjects were then recruited by the snowball sampling method in which the OBGYN Chief Directors sent the survey to their colleagues in the departments as well as posted the questionnaire link on WeChat to enable other acquaintances to take the survey. All participants were informed of the purpose, significance and specific implementation of this project. All data were collected anonymously by Wenjuan, an online survey software (<http://wenjuan.com>). The study was reviewed and received an exemption from Human Research Subject Regulations by the institutional review board at the University of South Carolina.

Participants & study area

A total of 898 participants submitted the survey and 340 of them were excluded because of an incomplete survey, non-eligible location, repeated submission and/or a non-female reproductive health specialty. All the remaining 558 eligible participants were working as obstetricians, gynecologists, fertility specialists and nurses in the OBGYN departments in Shanghai, China.

Statistical analyses

The SPSS 18.0 program (SPSS, Inc., IL, USA) was used for data entry and analysis. Descriptive data were shown as number (n), prevalence (%), mean and standard deviation. Correlation was assessed between demographic variables with Spearman's rank correlation. Binary logistic regression models were used to predict the impact of demographic characteristics on participants' oncofertility experience and attitude. To measure the association between demographic characteristics and oncofertility knowledge, an ordinal logistic regression model was used to obtain odds ratios (ORs) and 95% CIs. The Hosmer–Lemeshow test and the parallel lines test were applied to evaluate the suitability of binary and ordinal logistic regression models, respectively. A value of $p < 0.05$ was considered significant.

Results

Demographic information of participants

The demographic information of all 558 eligible participants is shown in [Supplementary Table 2](#). Briefly, about three-fourths of them (74.4%) were females, 94.6% of them were between 20 and 50 years of age, 64.9% of them had a bachelor's or higher educational degree, 81.5% of them were married, and 75.3% of them had at least one child. Among all participants, 41.4% of them were working in the OBGYN departments in the level 3-A hospitals, and the other 58.6% of them were from level 3-B or lower level hospitals. More than half of them (56.8%) had <10 years of working experience, and 23.3, 17.6 and 2.3% of participants had 10–20, 20–30 and >30 years, respectively.

Participants' oncofertility experience & attitude

Participants' oncofertility experience and attitude are shown in [Supplementary Table 3](#). Briefly, more than three-quarters of participants (77.1%) had been consulted by patients about their infertility before, with the frequency ranging from a daily to yearly basis. Although 90.7% of participants reported knowing that cancer therapy can impair female reproductive function, 31.4% of them were not familiar with the term 'fertility preservation'. Only 32.8% of the participants indicated that their working hospitals provided fertility preservation services despite that more than half of them (62.0%) were from level 3 hospitals. In addition, 83.0% of participants agreed that cancer patients would want to preserve their fertility before cancer therapy. About half of participants were consulted by a cancer patient (59.5%) or an oncologist (46.4%) about infertility risk from cancer therapy. The majority of participants (81.9%) reported to be willing to collaborate with oncologists to preserve cancer patients' fertility. With respect to questions about the importance of psychological consultation in oncofertility practice, 82.3% of participants reported that psychological counseling was important; however, almost half of their hospitals (44.3%) did not offer this service.

The impact of demographic characteristics on participants' oncofertility attitude

The gender, educational background, marital status, years of working experience, hospital level and number of children were included to determine the impact of demographic characteristics on participants' oncofertility attitude ([Table 1](#)). Results showed that female professionals were more likely to consider that cancer patients would want to preserve their fertility before cancer therapy ($p < 0.01$), whereas gender had no significant impact on other attitude questions. For all the included attitude questions, participants with higher educational backgrounds tended to have a more positive attitude toward oncofertility. Compared with unmarried participants, married participants were more likely to have a positive perspective on oncofertility as indicated by the questions of 'willing to collaborate with oncologists' ($p < 0.05$) and 'recognition of psychological consultation importance' ($p < 0.01$). Compared with participants with 1–10 years of working experience, participants with 11–20 years were more likely to be familiar with fertility preservation ($p < 0.05$) and were more likely to agree with the importance of psychological consultation in oncofertility practice ($p < 0.05$). However, a significantly smaller portion of them agreed that cancer patients would want to preserve their fertility before cancer therapy ($p < 0.05$). The hospital level and number of children had no significant impact on participants' attitude except that participants from level 2-A hospitals were more likely to have less familiarity on fertility preservation ($p < 0.05$) and that participants who had at least one child agreed less on the importance of psychological consultation ($p < 0.05$).

Table 1. Participants' attitude on cancer therapy-induced reproductive impairment and fertility preservation.

Demographics	OR				
	Attitude Q1	Attitude Q2	Attitude Q3	Attitude Q4	Attitude Q5
Gender:					
– Male	1	1	1	1	1
– Female	1.63	1.12 ^{††}	2.13	1.34	1.65
Educational background:					
– Undergraduate or below	1	1	1	1	1
– Bachelor's degree	1.63	1.13	2.18 [†]	2.03 [†]	1.34
– Master's degree	5.01 [†]	1.49	6.77 [†]	6.86 ^{††}	8.70 ^{††}
– PhD	2.42	5.87 [†]	2.75	13.31 [†]	3.51
Marital status:					
– Married	1	1	1	1	1
– Unmarried	0.41	0.79	0.38	0.32 [†]	0.17 ^{††}
Years of working experience:					
– 1–10	1	1	1	1	1
– 11–20	0.75	1.76 [†]	0.55 [†]	0.93	1.88 [†]
– 21–30	1.83	1.50	0.94	0.97	1.64
– >30	1.73	3.27	1.12	0.80	4.78
Hospital level:					
– Level 3-A	1	1	1	1	1
– Level 3-B	0.79	1.29	0.70	1.50	1.90
– Level 2-A	1.19	1.70 [†]	1.09	1.33	1.25
– Level 2-B and below	1.30	1.55	0.72	1.60	0.84
Number of children:					
– 0	1	1	1	1	1
– ≥1	0.83	1.16	0.49	0.65	0.29 [†]

Attitude Q1 represents 'recognition on reproductive damage of cancer therapy'; Attitude Q2 represents 'familiarity on fertility preservation'; Attitude Q3 represents 'agreement on cancer patients' willingness on fertility preservation'; Attitude Q4 represents 'willing to collaborate with oncologist'; and Attitude Q5 represents 'recognition of psychological consultation importance'.

[†] $p < 0.05$.

^{††} $p < 0.01$.

OR: Odds ratio.

Participants' oncofertility knowledge

For the last 12 questions regarding participants' oncofertility knowledge, each correctly answered question contributed one point to the total score. Scores were ranked and categorized as the following standard: 0–4 correct answers were defined as 'inadequate knowledge', 5–8 correct answers were defined as 'fair knowledge' and 9–12 correct answers were defined as 'good knowledge'. A higher score indicated having better oncofertility knowledge. The average score of all participants was 6.4 ± 2.9 , suggesting an overall fair oncofertility knowledge level for all the surveyed participants. Nearly half of the participants (45.7%) received scores at the 'fair knowledge' level, and 29.0 and 25.3% of them received scores at the 'good knowledge' and 'inadequate knowledge' levels, respectively.

The percentage of correct responses for each question is listed in Table 2. For the two questions with the highest percentages, 74.2 and 69.4% of participants correctly recognized that future pregnancy was not guaranteed with frozen eggs and frozen embryos, respectively. For the two questions with the lowest percentages, only 15.2% of participants knew that different anticancer treatment methods will result in different detrimental fertility impacts and >70% of participants incorrectly recognized that *in vitro* fertilization with embryo freezing was a treatment used only in patients without cancer. For most of the other knowledge questions, there was also a notable portion of participants (34.4–51.8%) with an inaccurate view of female fertility preservation. For instance, about half of the participants (43.9%) incorrectly recognized that insurance usually covers patients' fertility preservation treatments in China.

We next characterized the impact of demographic factors on participants' oncofertility knowledge levels (Table 3). Results indicated that the marital status, years of working experience, hospital level and number of children did not

Table 2. Correct rate of fertility preservation knowledge questions.

Knowledge question	Correct answer	Correct rate (%)
All cancer treatments result in infertility or premature menopause	False	65.6
A patient must have a spouse in order to pursue fertility preservation treatment	False	62.4
All fertility preservation treatments have similar success rates at achieving pregnancy	False	60.0
Insurance usually covers fertility preservation treatments	False	56.1
Fertility preservation methods are the same before and after cancer treatment	False	63.3
Women who utilize fertility preservation methods increase their risk of cancer recurrence in the future	False	48.2
Egg freezing and embryo freezing have the same chances of future pregnancy	False	53.9
A woman who freezes her eggs will have access to them whenever she is ready to use them in the future	True	54.1
Future pregnancy is guaranteed with frozen eggs	False	74.2
Future pregnancy is guaranteed with frozen embryos	False	69.4
<i>In vitro</i> fertilization with embryo freezing is a treatment used only in patients without cancer	False	21.3
The risk of birth defects in future children increases with chemotherapy treatments	False	15.2

Table 3. Impacts of demographic factors on participants' oncofertility knowledge.

Demographics	Inadequate knowledge (%)	Fair knowledge (%)	Good knowledge (%)	Average scores ($\pm$ SD)	OR
Gender:					
– Male	58 (40.5%)	53 (37.1%)	32 (22.4%)	5.3 ($\pm$ 3.1)	0.46 [†]
– Female	83 (20.0%)	202 (48.7%)	130 (31.3%)	6.8 ($\pm$ 2.7)	1
Educational background:					
– $\leq$ Undergraduate	65 (33.2%)	92 (46.9%)	39 (19.9%)	5.8 ($\pm$ 3.0)	0.26 [†]
– Bachelor	66 (26.4%)	123 (49.2%)	61 (24.4%)	6.2 ($\pm$ 2.8)	0.33 [†]
– Master	6 (6.8%)	31 (34.8%)	52 (58.4%)	8.2 ($\pm$ 2.1)	1.48
– PhD	4 (17.4%)	9 (39.1%)	10 (43.5%)	7.4 ($\pm$ 2.7)	1
Marital status:					
– Married	115 (25.3%)	218 (47.9%)	122 (26.8%)	6.4 ($\pm$ 2.8)	0.89
– Unmarried	26 (25.3%)	37 (35.9%)	40 (38.8%)	6.8 ($\pm$ 3.1)	1
Years of working experience:					
– 1–10	85 (26.8%)	136 (42.9%)	96 (30.3%)	6.4 ($\pm$ 3.0)	1.26
– 11–20	33 (25.4%)	59 (45.4%)	38 (29.2%)	6.5 ($\pm$ 2.9)	1.44
– 21–30	19 (19.4%)	53 (54.1%)	26 (26.5%)	6.7 ($\pm$ 2.3)	1.54
– >30	4 (30.8%)	7 (53.8%)	2 (15.4%)	6.2 ($\pm$ 2.9)	1
Hospital level:					
– Level 3-A	57 (24.7%)	96 (41.5%)	78 (33.8%)	6.6 ($\pm$ 3.0)	1.11
– Level 3-B	24 (20.9%)	55 (47.8%)	36 (31.3%)	6.7 ($\pm$ 2.8)	1.62
– Level 2-A	34 (23.3%)	80 (54.8%)	32 (21.9%)	6.5 ($\pm$ 2.5)	1.16
– Level 2-B and below	26 (39.4%)	24 (36.4%)	16 (24.2%)	5.5 ($\pm$ 3.2)	1
Number of children:					
– 0	32 (23.2%)	56 (40.6%)	50 (36.2%)	6.8 ($\pm$ 3.0)	1.20
– ≥ 1	109 (25.9%)	199 (47.4%)	112 (26.7%)	6.3 ($\pm$ 2.8)	1
– Total	141 (25.3%)	255 (45.7%)	162 (29.0%)	6.4 ($\pm$ 2.9)	

† $p < 0.05$.

OR: Odds ratio; SD: Standard deviation.

significantly affect participants' oncofertility knowledge. However, compared with males, female participants were more likely to receive a score at the 'good knowledge' level (22.4 and 31.3% in males and females, respectively, odds ratio: 0.46; $p < 0.01$). For participants with PhD or master's degree, 43.5 and 58.4% of them received scores at the 'good knowledge' level, respectively, which were significantly higher than the participants who did not go to college (19.9%, $p < 0.01$) or participants with a bachelor's degree only (24.4%, $p < 0.01$).

Discussion

China has the largest cancer population in the world and many of these patients are within or before their reproductive age. For example, there were about 280,000 newly diagnosed female breast cancer patients in 2014 and 61,900 of them were younger than 45 years of age, accounting for 17.8% of all reproductive-aged breast cancer population worldwide [17,18]. Due to the increased awareness of cancer therapy-induced reproductive damage and infertility, more and more women with cancer seek fertility preservation consultation and service. However, there are few fertility preservation guidelines available for both medical professionals and cancer patients in China. In order to further efforts to promote oncofertility practices in China, our study investigated the oncofertility attitude and knowledge of reproductive health professionals.

As one of the global financial centers and the city with the largest population in the world, Shanghai ranks first in the perspective of medical resource allocation based on the number of healthcare institutions, healthcare professional personnel, beds in healthcare institutions and healthcare investments [19]. In our study, 62.0% of participants worked in the level 3 hospitals, the top-level healthcare system in China; however, 58.7% of their working hospitals did not provide fertility preservation services, reflecting the deficiency of medical resources in the field of oncofertility in Shanghai. Moreover, although a majority of participants realized the reproductive damage of cancer therapy and agreed that cancer patients would want to preserve their fertility, 31.4% of them reported unfamiliarity with fertility preservation. These facts indicate the need of more oncofertility education and training for reproductive health professionals.

More than 80% of participants in our study reported they would be willing to collaborate with oncologists to help preserve patients' fertility. However, only half of them have ever been consulted by an oncologist or a patient about the infertility risk from cancer therapy. This inconsistency suggests a communication and referral gap between fertility specialists and oncologists within oncofertility practice. A recent study from Mahajan *et al.* reported a similar disparity between oncofertility attitude and practice among India gynecologists [20]. They found that 65% of the surveyed gynecological oncologists reported they would be willing to take patients' desire for future fertility into account when planning the surgical cancer treatment; however, only 23% of them have actually tried to provide a less gonadal toxic treatment strategy and >30% of them did not make an attempt at all [20]. To fill the communication gap, reproductive health professionals can take actions by collaborating with oncologists and disseminating oncofertility knowledge to both oncologists and cancer patients. Since oncologists are the first-line clinical professionals facing cancer patients' infertility risk, it is also critical for them to increase the awareness of fertility preservation and take proactive steps to protect patients' reproductive viability, such as initiating the discussion of fertility preservation with patients and referring them to a reproductive specialist.

Our results demonstrate that participants with different demographic characteristics have different oncofertility attitudes. Compared with males, female reproductive health professionals were more likely to recognize that cancer patients would want to preserve their fertility. This result is in line with a previous study, which found that female oncologists tended to be more willing to initiate a discussion with patients on childbearing after cancer than male oncologists, suggesting a sex difference in oncofertility attitude [21]. In addition, married participants held a more positive oncofertility attitude than unmarried participants, and participants with one or more children were more likely to agree on the importance of psychological consultation in oncofertility practice. These facts indicate that female and married clinicians and clinicians with kids are more likely to have empathy toward patients' infertility concerns as well as their desire of childbirth after cancer.

The positive correlation between participants' educational background and their oncofertility attitude demonstrates that the systemic medical training in higher levels of academic institutions will help improve their recognition on the importance of oncofertility. With respect to the years of working experience, participants with 11–30 years were more likely to show familiarity with fertility preservation and agree on the importance of psychological consultation. However, compared with participants with <10 years of working experience, it is surprising that they are less likely to agree that cancer patients would want to preserve their fertility before cancer therapy. In China, the ratio of doctors to general population is 1:735, which is substantially lower than that of western countries (1:280–1:640) [22]. When physicians' workload demand exceeds their capability, they are possibly unwilling to take on extra obligations including patients' infertility risk in addition to curing cancer [23]. Therefore, the more experienced physicians with heavier workloads may show a less favorable attitude toward patients' desire on fertility preservation [24,25]. Overall, our findings demonstrate the impact of participants' demographic background on their

oncofertility attitude, suggesting that these factors should be considered when planning oncofertility education and training.

The majority of participants (71.0%) obtained a fair or low level of oncofertility knowledge, particularly for the questions evaluating the gonadotoxicity of different anticancer regimens and fertility preservation options. For example, 85.8% of surveyed participants in our study considered that all anticancer treatments can cause infertility, which is consistent with a previous study reporting that >60% of surveyed oncologists did not consider and categorize the risk of gonadotoxicity of anticancer treatments [16]. However, the cancer therapy-induced female reproductive damages are determined by the treatment strategy, dose, duration and patients' susceptibility [26]. Moreover, about 80% of participants reported that embryo freezing can only be used for patients without cancer when in reality embryo cryopreservation is actually a favorable standard method for preserving young female cancer patients' fertility in the case that they have partner and the delayed cancer therapy is allowed [27]. This further suggests that despite a majority of participants realized cancer patients would want to preserve their fertility, a lack of oncofertility knowledge may adversely impact their capabilities of providing this service to patients.

There are several limitations in our study. First, selection bias may exist because most of our participants were recruited by the snowball sampling method indicating that those who completed the survey may have had more interest in cancer patients' fertility preservation. More representative survey sampling methods could be explored and used to avoid such bias in our future studies. Second, all participants were from one city, Shanghai, which does not represent the overall oncofertility progress in China, so we need to broaden our range of location in further studies. Third, recall bias may exist when answering the oncofertility experience questions, but in the future, we can use the historical medical record to further confirm these questions. Last, equally as important as reproductive health professionals, are oncologists who are the first ones to inform and advise cancer patients' infertility risk. Therefore, this specific population are also needed to be included in future studies.

Conclusion & future perspective

Our study reveals the oncofertility attitude and knowledge among reproductive health professionals in Shanghai, China. Most of the surveyed participants are basically familiar with the infertility risk from cancer therapy and they are generally supportive on preserving patients' fertility. However, the oncofertility attitude and knowledge might be affected by their demographic background such as gender, educational background and working experience. These results demonstrate that both systematic and individual reform and education are necessary for reproductive health professionals in China. Moreover, an interdisciplinary and inter-professional network of medical specialists, scientists and scholars should be established.

Executive Summary

Participants' oncofertility experience & attitude

- Although most of participants reported knowing that cancer therapy can impair female reproductive function, many of them were not familiar with the concept of fertility preservation.
- The majority of participants agreed that cancer patients would want to preserve their fertility before cancer therapy and were willing to collaborate with oncologists to preserve cancer patients' fertility.

The impact of demographic characteristics on participants' oncofertility attitude

- Female professionals were more likely to consider that cancer patients would want to preserve their fertility before cancer therapy.
- Participants with higher educational backgrounds tended to have a more positive attitude toward oncofertility.
- Married participants were more likely to have a positive perspective on oncofertility.

Participants' oncofertility knowledge

- There was an overall fair oncofertility knowledge level for all the surveyed participants.
- Female participants and those with a higher educational level were more likely to receive a score at the 'good knowledge' level.

Conclusions

- There are significant gaps in the current oncofertility knowledge among reproductive health professionals in China.
- There is an urgent, unmet need for establishing an interdisciplinary fertility preservation training and service system.

Supplementary data

To view the supplementary data that accompany this paper please visit the journal website at: www.futuremedicine.com/doi/suppl/10.2217/fon-2018-0428

Financial & competing interests disclosure

The authors would like to thank the support from the Arnold School of Public Health Start Up Fund to S Xiao, Magellan Scholar Program to S Xiao and M Kopp, and Magellan Mini Grant to S Xiao and S Johnson in the University of South Carolina. Additionally, this work was supported by the Center for Reproductive Health After Disease (P50HD076188) from the NIH National Center for Translational Research in Reproduction and Infertility. The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

No writing assistance was utilized in the production of this manuscript.

Ethical conduct of research

The authors state that they have obtained appropriate institutional review board approval or have followed the principles outlined in the Declaration of Helsinki for all human or animal experimental investigations. In addition, for investigations involving human subjects, informed consent has been obtained from the participants involved.

References

1. Chow EJ, Stratton KL, Leisenring WM *et al.* Pregnancy after chemotherapy in male and female survivors of childhood cancer treated between 1970 and 1999: a report from the Childhood Cancer Survivor Study cohort. *Lancet Oncol.* 17(5), 567–576 (2016).
2. Blumenfeld Z, Avivi I, Linn S, Epelbaum R, Ben-Shahar M, Haim N. Prevention of irreversible chemotherapy-induced ovarian damage in young women with lymphoma by a gonadotrophin-releasing hormone agonist in parallel to chemotherapy. *Hum. Reprod.* 11(8), 1620–1626 (1996).
3. Woodruff TK. Oncofertility: a grand collaboration between reproductive medicine and oncology. *Reproduction* 150(3), S1–S10 (2015).
4. Woodruff TK. The emergence of a new interdisciplinary: oncofertility. *Cancer Treat. Res.* 138, 3–11 (2007).
5. De Vos M, Smitz J, Woodruff TK. Fertility preservation in women with cancer. *Lancet* 384(9950), 1302–1310 (2014).
6. Abir R, Ben-Aharon I, Garor R *et al.* Cryopreservation of *in vitro* matured oocytes in addition to ovarian tissue freezing for fertility preservation in paediatric female cancer patients before and after cancer therapy. *Hum. Reprod.* 31(4), 750–762 (2016).
7. Ethics Committee of American Society for Reproductive Medicine. Fertility preservation and reproduction in patients facing gonadotoxic therapies: a committee opinion. *Fertil. Steril.* 100(5), 1224–1231 (2013).
8. Practice Committee of American Society for Reproductive Medicine. Fertility preservation in patients undergoing gonadotoxic therapy or gonadectomy: a committee opinion. *Fertil. Steril.* 100(5), 1214–1223 (2013).
9. Cherny NI, Sullivan R, Dafni U *et al.* A standardised, generic, validated approach to stratify the magnitude of clinical benefit that can be anticipated from anti-cancer therapies: the European Society for Medical Oncology Magnitude of Clinical Benefit Scale (ESMO-MCBS). *Ann. Oncol.* 28(11), 2901–2905 (2017).
10. Suzuki N. Clinical practice guidelines for fertility preservation in pediatric, adolescent, and young adults with cancer. *Int. J. Clin. Oncol.* 24(1), 20–27 (2019).
11. McGuire S. World Cancer Report 2014. Geneva, Switzerland: World Health Organization, International Agency for Research on Cancer, WHO Press, 2015. *Adv. Nutr.* 7(2), 418–419 (2016).
12. Chen W, Zheng R, Baade PD *et al.* Cancer statistics in China, 2015. *CA Cancer J. Clin.* 66(2), 115–132 (2016).
13. Zeng H, Chen W, Zheng R *et al.* Changing cancer survival in China during 2003–15: a pooled analysis of 17 population-based cancer registries. *Lancet Glob. Health* 6(5), e555–e567 (2018).
14. Maternal and Child Health Care of China Association. (2017). www.cmcha.org
15. Qiao Jie, Xia Xi LH. Fertility preservation and assisted reproduction issues of patients after treatment of gynecological malignancies. *J. Pract. Obstet. Gynecol.* 30(10), 729–731 (2014).
16. Balthazar U, Fritz MA, Mersereau JE. Fertility preservation: a pilot study to assess pre-visit patient knowledge quantitatively. *Fertil. Steril.* 95(6), 1913–1916 (2011).
17. Chen WQ, Sun KX, Zheng RS *et al.* Cancer incidence and mortality in China, 2014. *Chinese J. Cancer Res.* 30(1), 1–12 (2018).
18. GLOBOCAN. <http://globocan.iarc.fr/>
19. Liu W, Liu Y, Twum P, Li SX. National equity of health resource allocation in China: data from 2009 to 2013. *Int. J. Equity Health* 15, 68 (2016).

20. Mahajan N, Patil M, Kaur S, Kaur S, Naidu P. The role of Indian gynecologists in oncofertility care and counseling. *J. Hum. Reprod. Sci.* 9(3), 179–186 (2016).
21. Velikova G, Awad N, Coles-Gale R, Wright EP, Brown JM, Selby PJ. The clinical value of quality of life assessment in oncology practice – a qualitative study of patient and physician views. *Psychooncology* 17(7), 690–698 (2008).
22. Li L. *Social Medicine*. People's Medical Publishing House, Beijing, China (2007).
23. Yousuf RM, Fauzi AR, How SH, Rasool AG, Rehana K. Awareness, knowledge and attitude toward informed consent among doctors in two different cultures in Asia: a cross-sectional comparative study in Malaysia and Kashmir, India. *Singapore Med. J.* 48(6), 559–565 (2007).
24. Zhang YM, Feng XS. The relationship between job satisfaction, burnout, and turnover intention among physicians from urban state-owned medical institutions in Hubei, China: a cross-sectional study. *BMC Health Serv. Res.* 11, 235 (2011).
25. Wang Y, Liu L, Wang JN, Wang L. Work-family conflict and burnout among Chinese doctors: the mediating role of psychological capital. *J. Occup. Health* 54(3), 232–240 (2012).
26. Meirow D, Biederman H, Anderson RA, Wallace WHB. Toxicity of chemotherapy and radiation on female reproduction. *Clin. Obstet. Gynecol.* 53(4), 727–739 (2010).
27. Bedoschi G, Oktay K. Current approach to fertility preservation by embryo cryopreservation. *Fertil. Steril.* 99(6), 1496–1502 (2013).