

Knowledge, attitudes, and intentions toward fertility awareness and oocyte cryopreservation among obstetrics and gynecology resident physicians

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STUDY QUESTION: What knowledge, attitudes and intentions do US obstetrics and gynecology (OB/GYN) residents have toward discussing age-related fertility decline and oocyte cryopreservation with their patients?

SUMMARY ANSWER: Most OB/GYN residents believe that age-related fertility decline, but not oocyte cryopreservation, should be discussed during well-woman annual exams; furthermore, nearly half of residents overestimated the age at which female fertility markedly declines.

WHAT IS KNOWN ALREADY: Oocyte cryopreservation can be utilized to preserve fertility potential. Currently, no studies of US OB/GYN residents exist that question their knowledge, attitudes, and intentions toward discussing age-related fertility decline and oocyte cryopreservation with patients.

STUDY DESIGN, SIZE, DURATION: A cross-sectional online survey was conducted during the fall of 2014 among residents in American Council for Graduate (ACOG) Medical Education-approved OB/GYN residency programs. Program directors were emailed via the ACOG Council on Resident Education in Obstetrics and Gynecology server listing and asked to solicit resident participation.

PARTICIPANTS/MATERIALS, SETTING, METHODS: Participants included 238 residents evenly distributed between post-graduate years 1–4 with varied post-residency plans; 90% of residents were women and 75% were 26–30 years old. The survey was divided into three sections: demographics, fertility awareness, and attitudes toward discussing fertility preservation options with patients. Descriptive and inferential statistics were conducted.

MAIN RESULTS AND THE ROLE OF CHANCE: A strong majority of residents (83%) believed an OB/GYN should initiate discussions about age-related fertility decline with patients (mean patient age 31.8), and 73% percent believed these discussions should be part of an annual exam. One third of residents overestimated the age at which there is a slight decline in female fertility, while nearly half of residents overestimated the age at which female fertility markedly declines. Over three-quarters of residents (78.4%) also overestimated the likelihood of success using assisted reproductive treatments (ARTs). Residents were likely to support oocyte cryopreservation in cancer patients irrespective of the woman's age, but much less likely to support elective oocyte cryopreservation. For elective oocyte cryopreservation, 40% believed OB/GYNs should initiate discussions with patients (mean age 31.1), while only 20% believed this topic should be part of an annual exam.

LIMITATIONS, REASONS FOR CAUTION: Because the study invitation was sent through US OB/GYN residency program directors rather than directly to residents, it is possible that some residents did not receive the invitation to participate. This limits the generalizability of the findings.

WIDER IMPLICATIONS OF THE FINDINGS: Within the USA, there appears to be a critical need for improved education on fertility decline in OB/GYN residency programs. To promote informed reproductive decision-making among patients, efforts should be made to help OB/GYNs provide comprehensive fertility education to all women, while also respecting patient choices.

STUDY FUNDING/COMPETING INTEREST(S): None.

Key words: fertility awareness / fertility preservation / age-related fertility decline / elective oocyte cryopreservation / medical oocyte cryopreservation / oocyte storage / ovarian aging / reproductive health education / obstetrics and gynecology residents / physicians

Introduction

Studies assessing the relationship between female fertility and aging have utilized a variety of approaches, including observational data on study populations, statistical modeling, and biochemical assays (Howe et al., 1985; Menken and Larken, 1986; Dunson et al., 2002; Broekmans et al., 2006; Eijkemans et al., 2014). Although the specified age of onset of fertility decline varies among studies, there is widespread agreement that female fertility begins to decline by a woman's early 30s, and that the rate of decline markedly increases at age 37 and thereafter (Howe et al., 1985; Dunson et al., 2002; Te Velde and Pearson, 2002; ASRM, 2013; ACOG, 2014). However, a large number of international studies have consistently found that people who are likely to delay childbearing underestimate the impact of age on fertility as a potential risk factor for involuntary childlessness (Lampic et al., 2006; Tyden et al., 2006; Bretherick et al., 2010; Hashiloni-Dolev et al., 2011; Virtala et al., 2011; Peterson et al., 2012; Wyndham et al., 2012; Chan et al., 2015). These studies also found that participants overestimate the effectiveness of assisted reproductive treatments (ARTs) to overcome age-related infertility (Leridon, 2004; Ferraretti et al., 2013; Center for Disease Control & Prevention, 2014). It is therefore particularly important that women of childbearing age have access to accurate information regarding the impact of age on fertility, as well as the success rates of both ARTs and fertility preservation, so that they are empowered to make informed reproductive decisions.

Most women who want children report that their health care provider is the preferred and most reliable source of information about reproductive health, rather than other sources such as the media, peers, and the Internet (Peterson et al., 2012; Wyndham et al., 2012; Hodes-Wertz et al., 2013; Lundsberg et al., 2014; Azhar et al., 2015). However, women typically wait to seek information from their health care providers on fertility and conception until they are older, when their fertility may already be declining or compromised (Lundsberg et al., 2014). Furthermore, not all health care providers are familiar with or comfortable counseling their patients about age-related fertility decline. This combination of patient and physician factors may lead to a relatively low percentage of patients who actually receive reproductive health-related information directly from their health care providers (Lundsberg et al., 2014). Primary care physicians, and to a greater extent obstetric and gynecology (OB/GYN) specialists in hospitals and general practice, have an important role to play in educating patients about the relationship between age and fertility. They are also in a position to discuss the implications of oocyte cryopreservation such as cost, risk, and the estimated number of eggs needed to give women a reasonable chance of having a baby as a result (Dondorp et al., 2012). For example, doctors can present the possibility of freezing one's eggs for future use at a time of maximum reproductive potential. Although oocyte cryopreservation is clearly gaining acceptance for use in patients diagnosed with cancer (Mertes and Pennings, 2011; Noyes et al., 2011), considerable controversy exists regarding the use of oocyte cryopreservation for non-medical reasons (Stoop et al., 2011, 2014). In October 2012, the American Society for Reproductive Medicine (ASRM) removed the

experimental label from oocyte cryopreservation for medical reasons, given that it has similar obstetric and perinatal outcomes compared with procedures using fresh oocytes (Oktay et al., 2006; Grifo and Noyes, 2010; Herrero et al., 2011; Rienzi et al., 2012; ASRM, 2013; Levi Setti et al., 2013; Cobo et al., 2014). However, because of the newness of the procedure, total success rates after long-term freezing remain unclear making it difficult to counsel women in either group on the minimum number of oocytes required to have a reasonable chance of birth after oocyte cryopreservation.

To provide a more neutral and accurate description of this technology, we will refer to oocyte cryopreservation for non-medical reasons as 'elective oocyte cryopreservation' (EOC). Although EOC has the potential to alter the landscape of female fertility decision-making, it is of paramount importance to assess whether OB/GYNs—considered the first-line providers of comprehensive reproductive health education—feel that they have a responsibility to educate patients about fertility decline and EOC, and whether they have the necessary education to perform this function. As fertility preservation technologies become more available in the USA, OB/GYN awareness of these technologies may have a major impact on whether fertility decline is discussed, and if EOC options are presented to women during their routine gynecologic exams.

OB/GYN residents, currently in post-graduate training, may be the most likely physicians to integrate new evidence-based medicine and technologies into their practice. Thus, this study was designed to examine the knowledge, attitudes, and intentions of US OB/GYN residents in providing patients with information on age-related fertility decline and oocyte cryopreservation. Our study aims to assess OB/GYN residents' knowledge and beliefs regarding age-related fertility decline and the use and availability of oocyte cryopreservation. It is based on three key research questions: (i) Do OB/GYN residents believe that it is the role of OB/GYNs to initiate discussions about age-related fertility decline and oocyte cryopreservation with their patients, and if so, at what ages and how frequently? (ii) Do OB/GYN residents possess accurate knowledge regarding the relationship between female fertility decline and age, as well as the success rates of ARTs? And (iii) Do OB/GYN residents differ in their attitudes toward oocyte cryopreservation for patients diagnosed with cancer or other medical conditions versus EOC? To our knowledge, this is the first study to examine these issues in a sample of US OB/GYN resident physicians.

Materials and Methods

The study used a cross-sectional design to examine the knowledge, attitudes, and intentions of US OB/GYN residents. The study was reviewed and approved by the Yale University Human Investigation Committee (HIC#1409014546). All 232 residency program directors listed on the website of the American College of Obstetrician Gynecologists (ACOG) were sent a hyperlink to an online survey and asked to forward this link to their residents. Resident participants had an opportunity to enter a raffle for one of six \$50 incentives at the completion of the survey. Between September and October 2014, an initial invitation email and two reminder emails

were sent to each program director with a request to forward the invitation to all residents.

Instrument design

The survey was based on existing instruments measuring fertility awareness (Lampic *et al.*, 2006), and the clinical experiences of the study authors in the fields of obstetrics and gynecology, reproductive endocrinology, psychology, and anthropology. The instrument was pre-tested on a small group of graduate students for clarity and wording, and was refined through discussion with this focus group as well as a literature review examining the published research on fertility awareness, preconception counseling, and oocyte cryopreservation. The survey included demographic background questions and questions about residents' attitudes towards discussing age-related fertility decline and oocyte cryopreservation. Questions took the form of 'yes/no' responses (e.g. 'Should an OB/GYN initiate discussions with patients regarding childbearing intentions?'), and open-ended numerical questions (e.g. 'If you answered YES to [the previous question], at what age would you initiate this discussion with patients?'). Participants were also asked whether these conversations were appropriate for annual well-woman exams, and data were collected regarding the reasons for or against discussing childbearing intentions at well-woman exams. Options for open-ended qualitative responses using an 'other' category were also given to more thoroughly assess residents' attitudes. As in previous studies of fertility awareness, knowledge-based questions included age of 'slight' versus 'marked' decline in a woman's ability to become pregnant, and the average success rate for couples undergoing a single round of *in vitro* fertilization (IVF) (Lampic *et al.*, 2006; Peterson *et al.*, 2012; Chan *et al.*, 2015). Participants were asked to assess their own familiarity with oocyte cryopreservation, and whether oocyte cryopreservation was offered at their training institution. They were also asked whether they would initiate discussions of oocyte cryopreservation with their patients, at what ages they would initiate such discussions, and whether such discussions should be part of a well-woman annual exam. Finally, residents were asked how likely they would be to discuss oocyte cryopreservation and support insurance coverage for the technology in different clinical situations (e.g. 'A 25-year-old with cancer') or for non-medical reasons (e.g. 'A 25-year-old who wants a career first').

Statistical analysis

Data from the online survey were analyzed using SPSS (Version 21). Characteristics of study participants were first analyzed with descriptive statistics. Next, descriptive analyses regarding issues related to fertility awareness, preconception planning, and oocyte cryopreservation were conducted. OB/GYN residents' knowledge of fertility issues was then examined with analyses of variance (ANOVAs), which tested whether knowledge differed based on participants' year in residency. Gender differences were not examined due to the small sample size of male residents.

Results

Sample characteristics

Two hundred thirty nine residents participated in the online survey, or approximately 5% of all OB/GYN residents in the United States (based on 5021 total OB/GYN residents reported by the Accreditation Council for Graduate Medical Education) (ACGME, 2014). As shown in Table I, approximately 75% of residents were between the ages of 26 and 30. In addition, a significantly higher percentage of respondents were women (90.3% versus 81%, $z = 3.72$, $P < 0.0001$) and white (71.7% versus 54%, $z = 5.46$, $P < 0.0001$) when compared with the overall population of residents (ACGME, 2014). Respondents were nearly equally split across year of residency and slightly more hailed from the

Table I Characteristics of the sample.

Characteristic	N	%
Age		
18–25	7	2.9
26–30	179	74.9
31–35	51	21.3
36–40	2	0.8
41–45	0	0
Gender		
Female	214	90.3
Male	23	9.7
Other	0	0
Racial/ethnic background		
White/Caucasian	170	71.7
Black/African American	16	6.8
Asian and Pacific Islander	27	11.4
Hispanic/Latino	12	5.1
Middle Eastern	3	1.3
Multiracial	6	2.5
Other	3	1.3
Post-graduate year		
1	62	25.9
2	66	27.6
3	53	22.2
4	57	23.8
Other	1	0.4
Geographic location		
West	35	14.8
Midwest	45	19
Northeast	90	38
South	59	24.9
Other	8	3.4
Professional plans		
Maternal fetal medicine	18	7.5
Reproductive endocrinology and infertility	18	7.5
Urogynecology	17	7.1
Gynecologic oncology	26	10.9
Family planning	12	5
Other fellowship	10	4.2
General practice	120	50.2
Other	18	7.5

northeastern and southern regions of the USA compared with the western and mid-western regions. Half of respondents (50.2%) intended to pursue general practice in the future.

Attitudes toward discussing preconception planning and fertility

Findings regarding residents' tendencies to discuss preconception planning and fertility with patients are shown in Table II. Nearly all respondents

Table II OB/GYN residents' attitudes toward discussing preconception planning and fertility.

Item	N	%
Should an OB/GYN initiate discussions with patients about their potential childbearing intentions?		
Yes	198	91.7
No	18	8.3
Should an OB/GYN initiate discussions about age-related fertility decline with patients?		
Yes	180	82.9
No	37	17.1
Should discussing the natural decline in fertility with age be part of a well-woman annual exam with a gynecologist?		
Yes	157	72.4
No	60	27.6
Reasons for yes		
Educating women about this helps women make informed reproductive decisions	141	89.8
I want to provide comprehensive health education to my patients	127	80.9
Women should be aware of the correct relationship between fertility and age	112	71.3
I can help dispel many of the myths in society/media regarding fertility and age	85	54.1
Other	0	0
Reasons for no		
Bringing this issue up annually is too frequent, but I am not opposed to discussing this issue with patients every three to four years	32	53.3
I don't want to be perceived as pushing childbearing on patients	32	53.3
Bringing up this issue annually may lead to emotional distress in my patients	24	40
I want to be able to fully respect patient choices	23	38.3
I don't have enough time	7	11.7
Other	7	11.7
It is not my primary responsibility	2	3.3

(91.7%) indicated that OB/GYNs should initiate discussion with patients about childbearing intentions at a patient's mean age of 20.8 (SD = 5.4). A majority of respondents also thought that OB/GYNs should initiate discussions about age-related fertility decline (82.9%), although beginning at a patients' mean age of 31.8 (SD = 3.5). Furthermore, 72.4% thought that discussing age-related fertility decline should be part of a well-woman annual exam with an OB/GYN, as this would help to educate women about making informed reproductive decisions. Of the 27.6% of residents who did not think that discussing age-related fertility decline should be part of a well-woman annual exam, 53% explained that an annual exam was too frequent, 53% did not want to be perceived as pushing childbearing on their patients, and 40% reported that such discussions might lead to emotional distress in patients.

Awareness of fertility issues

Residents' knowledge about the ages when female fertility declines and their estimate of chance of success with IVF are shown in Table III.

One third overestimated the age when fertility starts to decline and almost half of residents (46.5%) overestimated when fertility declines markedly. Estimates of slight and marked decline in fertility did not differ based on year in residency.

Residents also overestimated the overall chance of success in having a child after undergoing one IVF treatment cycle, as more than three-quarters of residents (78.4%) believed that the success rate was 30% or higher. The respondents' mean estimate of overall success was 42.3% (SD = 18.4%; minimum = 5%; maximum = 80%). Estimates for success after IVF did not differ by residency year.

Familiarity with oocyte cryopreservation and attitudes toward use

Residents' attitudes towards the use of oocyte cryopreservation are presented in Table IV. Only one in four residents (25.1%) indicated that they were either 'familiar' or 'very familiar' with oocyte cryopreservation. However, six in ten residents (62.6%) worked at a training institution that offered oocyte cryopreservation to patients, suggesting a lack of education within US institutions' OB/GYN residency programs about these new technologies.

Sixty percent of respondents did not think that OB/GYNs should initiate discussion of oocyte cryopreservation with their female patients. Of the 40% of respondents who did think that OB/GYNs should initiate discussion, the mean patient age at which such discussions would occur was 31.1 (SD = 4.2). Even fewer respondents (20.4%) thought that discussion of oocyte cryopreservation should be part of an annual well-woman exam. Reasons given for discussing oocyte cryopreservation during an annual exam included educating women to make informed reproductive choices and helping them understand the implications of oocyte cryopreservation. Reasons against discussing this issue during an annual exam included wanting to be respectful of patient choices and not wanting to be perceived as pushing childbearing.

Likelihood of discussing or supporting oocyte cryopreservation for different patient situations

When presented with different patient scenarios, residents showed varying levels of support for discussing oocyte cryopreservation. As shown in Fig. 1, residents were very likely to discuss oocyte cryopreservation with patients who had received a cancer diagnosis, regardless of whether that patient was 25 or 35 years of age. In contrast, residents were either somewhat or very unlikely to discuss EOC with patients who wanted to pursue a career before starting a family, especially for younger patients. Similar patterns were evident for residents' support of insurance coverage of oocyte cryopreservation, with many more residents likely to support insurance coverage for patients who had received a cancer diagnosis versus those who wished to pursue a career prior to starting a family (data not shown).

Discussion

To our knowledge, this is the first study to examine the attitudes, knowledge, and intentions regarding fertility awareness and oocyte cryopreservation among US OB/GYN residents. Nearly all residents (92%) who completed the survey believed that an OB/GYN should initiate discussions regarding their patients' childbearing intentions. Furthermore,

Table III Obstetrics and gynecology (OB/GYN) residents' awareness of fertility issues.

Fertility issue	All residents (N = 217)	1st year residents (N = 55)	2nd year residents (N = 58)	3rd year residents (N = 51)	4th year residents (N = 53)	P
At what age is there a <i>slight</i> decrease in women's ability to become pregnant?	31.67 (3.10)	31.55 (3.47)	31.43 (2.74)	31.37 (2.95)	32.36 (3.21)	0.32
15–24	0.9%	1.8%	0%	0%	1.9%	
25–29*	9.7%	9.1%	10.3%	15.7%	3.8%	
30–34*	53.0%	50.9%	60.3%	54.9%	45.3%	
35–59	33.1%	38.2%	29.3%	29.4%	49.1%	
At what age is there a <i>marked</i> decrease in women's ability to become pregnant?	37.58 (2.53)	37.95 (2.54)	37.17 (2.62)	37.20 (2.51)	38.00 (2.39)	0.15
25–34	0%	0%	0%	0%	0%	
35–39*	52.5%	47.3%	60.3%	58.8%	43.4%	
40–44	46.5%	50.9%	37.9%	41.2%	56.6%	
45–59	0.9%	1.8%	1.7%	0%	0%	
What is the overall chance, on average, that a couple who undergoes treatment with <i>in vitro</i> fertilization will have a child after one treatment?	42.30 (18.37)	41.20 (19.52)	45.02 (18.75)	42.02 (18.61)	40.75 (16.62)	0.61
0–19%	5.1%	7.3%	1.7%	5.9%	5.7%	
20–29%*	16.6%	16.4%	17.2%	13.7%	18.9%	
30–39%	24.0%	29.1%	19.0%	29.4%	18.9%	
40–100%	54.4%	47.3%	62.1%	51.0%	56.6%	

*Asterisk indicates the correct category based on published literature. For the slight decline in fertility, literature suggests this decline can begin in the late 20s to early 30s. Note. Means and standard deviations are presented in the first row for each fertility issue; percentages are presented in subsequent rows. Significance values come from one-way analyses of variance testing for differences based on year in residency.

83% of residents said that they believed an OB/GYN should initiate discussions about age-related fertility decline with female patients, and 72% said that these discussions should be a part of an annual well-woman exam. These findings are encouraging, as numerous international studies have shown that women who are likely to delay childbearing also lack awareness of age-related fertility decline. A recent study sampling fertility patients from 79 countries found that accurate fertility knowledge was reported by only 56.9% of patients, supporting the need for more education (Bunting et al., 2013). Although physicians and other health care providers should be the first-line reproductive health educators for women (Peterson et al., 2012; Wyndham et al., 2012; Hodes-Wertz et al., 2013), studies show that many women report never having discussed the effect of age on their ability to conceive, even though they identify their health care providers as their top source of information on fertility and reproductive health (Lundsberg et al., 2014).

Although it is encouraging that the majority of OB/GYN residents believe that physicians should initiate discussions about fertility decline with their patients, a surprisingly large percentage of the residents surveyed were misinformed about fertility decline themselves. For example, 33% of residents believed female fertility slightly declines at age 35 or after, and nearly half (46.5%) of residents indicated that fertility declines markedly at age 40 or after—when, in fact, the marked decline occurs on average around the age of 37 (Dunson et al., 2002; ASRM, 2013). Given that OB/GYNs are the gatekeepers of the dissemination of correct reproductive knowledge, it is concerning that nearly half of the residents in this study were so uninformed about these basic reproductive facts. Furthermore, given that prior studies suggest that provision

of fertility information impacts patient knowledge and intentions toward delaying childbearing (Williamson et al., 2014), these findings highlight a critical need for improved education and curricular offerings on age-related fertility decline in OB/GYN residency programs in the USA.

In addition to misconceptions about age-related infertility, residents in this study were also misinformed about the success rates of ARTs. Over three-quarters of residents (78.4%) overestimated the likely success of IVF in treating infertility. OB/GYN residents seem to share the common misconceptions—perpetuated by inaccurate media reports, especially of ‘celebrity moms’—that women can delay having children until after 40, and that any difficulties can be overcome through IVF (Wyndham et al., 2012). It is important to educate practitioners that ARTs such as IVF can only make up for half of the births lost by postponing a first attempt to conceive from age 30 to 35, so that they may correct any misperceptions that patients may have (Leridon, 2004; Wyndham et al., 2012; ASRM, 2013). ART success rates are directly related to the age of the patient. For example, women under 35 in the United States have a 41.5% chance for a live birth using IVF. However, for older women—who may have intentionally postponed childbearing under the false impression that ARTs could correct any difficulties with fertility—only 11.7% of women aged 41–42, and only 4.5% of women ages 43–44 had a live birth (CDC, 2014). In other words, women who use ART in their 40s are much less likely than younger women to have a live birth as a result.

When OB/GYN residents in this study were asked whether they should initiate discussions regarding oocyte cryopreservation with patients, less than half (40%) believed that OB/GYNs should, and only

Table IV Obstetrics and gynecology (OB/GYN) residents' attitudes toward use of oocyte cryopreservation.

Item	N	%	
Should an OB/GYN initiate discussions regarding oocyte cryopreservation with female patients?			
Yes	83	39.9	
No	125	60.1	
Should discussing oocyte cryopreservation be part of a well-woman annual exam with a gynecologist?			
Yes	42	20.4	
No	164	79.6	
Reasons for yes	Educating women about this issue helps women make more informed reproductive decisions	33	78.6
	Understanding the implications of oocyte cryopreservation increases women's childbearing choices	31	73.8
	I want to provide comprehensive health education to all my patients	28	66.7
	Other	1	2.4
	Reasons for no	Bringing this issue up annually is too frequent, but I am not opposed to discussing this issue with patients every three to four years	79
	I don't want to be perceived as pushing childbearing on patients	49	29.9
	Other	45	27.4
	Bringing up this issue annually may lead to emotional distress in my patients	44	26.8
	I want to be able to fully respect patient choices	40	24.4
	It is not my primary responsibility	28	17.1
	I don't have enough time	25	15.2

one-fifth (20%) reported that it should be a part of an annual well-woman exam. In a 2013 study of 183 women who had undergone at least one oocyte cryopreservation cycle, the mean age of patients who cryopreserved their oocytes was 38, an age at which oocytes already have reduced quality and reproductive potential (Hodes-Wertz et al., 2013). Furthermore, 79% of the women wished they had undergone EOC at an earlier age, and only one-third had discussed EOC with their gynecologist prior to the procedure. In the current study, residents believed OB/GYNs should initiate discussions about EOC with patients starting at age 31, an age when a woman's reproductive potential is greater than the current norm among actual EOC users, who are on average freezing their oocytes in their late 30s. Recent data from decision-analysis models propose that the highest probability of achieving a live birth may be when women undertake EOC at < 34 years of age (Mesen et al., 2015). Also, cost-effectiveness studies show that freezing oocytes by age 35 in women who plan to delay childbearing until age 40 effectively reduces the cost per live birth (Devine et al., 2015).

In considering the role of physicians in discussing these issues with patients, it is important to note that childbearing decisions are also influenced by relational circumstances or other factors that are beyond a patient's immediate control. For example, in a study of women who underwent EOC to preserve their fertility, 161 (88%) had delayed childbearing because they lacked a partner (Hodes-Wertz et al.,

2013). OB/GYNs should be sensitive to these possibilities while delivering information about fertility decline and EOC. However, EOC may offer some women relief from the pressure of entering into an unwanted relationship 'for the sake of children,' or to have children before they are ready. Counseling women about their fertility and the possibility of EOC requires both maximal sensitivity and respect for patients' reproductive autonomy. Yet, ideally, OB/GYNs should be initiating such discussions with their patients at an age when patients' reproductive potential can be maximized (the late 20s to early 30s) and when women may have the greatest flexibility in reproductive decision making.

We acknowledge an absence of studies that examine how women may respond to such discussions. However, we support the conclusions of other studies that call for research to investigate if patients want physicians to initiate these types of discussions, and under what circumstances they would like them to take place (Buske et al., 2015). The results of such research would be useful for OB/GYN training programs around the world, in order to teach residents how to deliver information about age-related fertility decline and oocyte cryopreservation in a way that respects patient circumstances, while providing education required for informed decision-making.

Examining the attitudes and knowledge of physicians regarding fertility preservation is critical, and this need has been highlighted in several international studies. For example, in Germany, a survey of 120 oncologists found that while nearly all of the physicians felt fertility preservation was an important issue, only half reported having a thorough understanding of it, and only 40% reported discussing it with patients routinely (Buske et al., 2015). A recent study of breast cancer specialists in Japan found that physicians who had more positive attitudes toward fertility preservation were more likely to discuss this with patients, and calls were made to improve interdisciplinary communication between physicians and infertility specialists to improve patient care (Shimizu et al., 2013). Countries around the world are also beginning to incorporate EOC into standard fertility care, with some nations considering oocyte cryopreservation to be cost effective and thus potentially covered by insurance or national health plans (Shkedi-Rafid et al., 2011; Van Loendersloot et al., 2011). In the current study, residents suggested that they would be more likely to support insurance coverage for oocyte cryopreservation in cancer patients than for age-matched patients seeking EOC. Thus, future studies must examine how financial coverage of these technologies might impact attitudes toward and uses of both medical oocyte cryopreservation and EOC in countries throughout the world.

Finally, it is important to note that women do not typically make their reproductive decisions alone, and often include male partners. Men have also been found to significantly overestimate the ages at which female fertility declines (Peterson et al., 2012). Furthermore, some data have shown that women's desire for childbearing may be related in part to whether a male partner desires children (Holton, et al., 2011). Given that reproductive health and the impact of fertility treatments have increasingly been conceptualized as a couple's issue (Peterson et al., 2009, 2011), it is important that providers of men's health care also be encouraged to seek appropriate education regarding age-related fertility decline. As noted in a recent review, men are often the 'forgotten partner' when couples are diagnosed with infertility – even in cases of male-factor infertility (Petok, 2015). Once a couple is diagnosed with infertility, both partners participate in the help seeking process (Johnson and Johnson, 2009). Thus, leaving men out of reproductive counseling

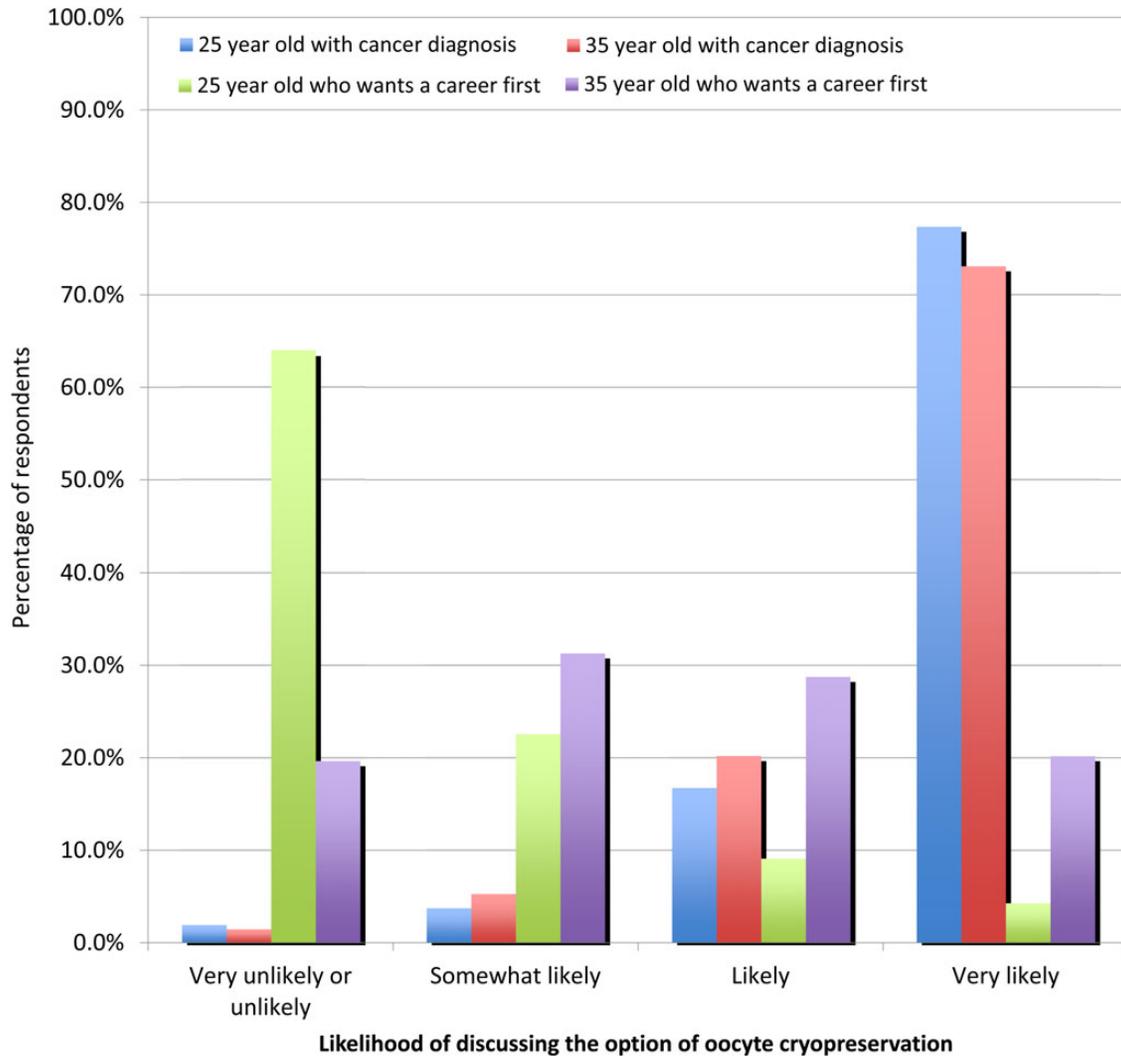


Figure 1 Likelihood of discussing medically indicated and elective oocyte cryopreservation by age.

overlooks the significant contribution that men make to reproduction (Inhorn *et al.*, 2009). Discussions of fertility decline and oocyte cryopreservation can include men as well as women, so that both individuals and couples are better informed about their full range of reproductive options (Azhar *et al.*, 2015).

Limitations

The findings of this study must also be interpreted in light of the study's limitations. First, due to our sampling methods, we were unable to calculate the exact number of residents who actually received a recruitment email. Because residents completed the survey in an online, anonymous questionnaire format, we must take into account the possibility for bias in the study findings. Inherent to email-based sampling is self-selection bias; we were unable to evaluate characteristics of non-respondents and thus cannot be sure that our findings may therefore not be generalizable to all residents. In addition, female residents were slightly over-represented in our sample when compared with the proportion of female OB/GYN residents in the USA (AAMC, 2014; ACGME, 2014). The study also

did not address residents' attitudes and intentions regarding the education of men about fertility decline and oocyte cryopreservation. Finally, due to the small number of male respondents, analyses lacked sufficient power to explore gender differences among the study responses.

Conclusion

This study is the first of its kind to examine the knowledge, attitudes, and intentions of US OB/GYN residents in providing patients with information on age-related fertility decline and oocyte cryopreservation. The findings highlight a critical need for improved education among US OB/GYN residents about issues related to age-related fertility decline and the use of oocyte cryopreservation for both medical and elective reasons. Although our study focused on OB/GYN residents in the USA, topics of reproductive health and fertility are universal; thus, further research is needed to explore the role of education across cultures and in countries where OB/GYN training programs may differ in duration and method. If OB/GYNs are taught to present fertility decline and oocyte cryopreservation to patients in a way that is both

respectful of individual patient autonomy and informative about new reproductive technologies, then they will maximize their patients' ability to make the most informed reproductive decisions possible.

Supplementary data

Supplementary data are available at <http://humrep.oxfordjournals.org/>.

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Authors' roles

P.P. proposed the study, design and reviewed and analyzed data; L.Y. and B.P. designed the study instrument, implemented the study, analyzed data, and prepared the initial manuscript; J.K.B. conducted data analysis and statistics and assisted with manuscript preparation; M.C.I. edited the manuscript and further enhanced data analysis.

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Conflict of interest

None declared.

References

- AAMC. *AAMC Physician Specialty Databook*. Washington, D.C.: Association of American Medical Colleges (AAMC), 2014.
- ACGME. *Graduate Medical Education Data Resource Book*. Chicago, IL: Accreditation Council for Graduate Medical Education (ACGME), 2014.
- ACOG. Female age-related fertility decline. Committee Opinion No. 589. *Obstet Gynecol* 2014; **123**:719–721.
- American Society for Reproductive Medicine (ASRM). Practice Committees of the American Society for Reproductive Medicine and Society for Assisted Reproductive Technology: mature oocyte cryopreservation: a guideline. *Fertil Steril* 2013; **99**:37–43.
- Azhar E, Seifer DB, Malzer K, Ahmed A, Weedon J, Minkiff H. Knowledge of ovarian reserve and reproductive choices. *J Assist Reprod Genet* 2015; **32**:409–415.
- Bretherick KL, Fairbrother N, Avila L, Harbord SH, Robinson WP. Fertility and aging: do reproductive-aged Canadian women know what they need to know? *Fertil Steril* 2010; **93**:2162–2168.
- Broekmans FJ, Kwee J, Hendriks DJ, Mol BW, Lambalk CB. A systematic review of tests predicting ovarian reserve and IVF outcome. *Hum Reprod Update* 2006; **12**:685–718.
- Bunting L, Tsiibulsky I, Boivin J. Fertility knowledge and beliefs about fertility treatment: findings from the international fertility decision-making study. *Hum Reprod* 2013; **28**:385–397.
- Buske D, Sender A, Richter D. Patient-physician communication and knowledge regarding fertility issues from German oncologists' perspective—a quantitative survey. *J Cancer Educ* 2015; **1**:1–8.
- Centers for Disease Control and Prevention, American Society for Reproductive Medicine, Society for Assisted Reproductive Technology. 2012 Assisted Reproductive Technology Fertility Clinic Success Rates Report. Atlanta, GA: US Department of Health and Human Services, 2014.
- Chan CH, Chan TH, Peterson BD, Lampic C, Tam MY. Intentions and attitudes towards parenthood and fertility awareness among Chinese university students in Hong Kong: a comparison with Western samples. *Hum Reprod* 2015; **30**:364–372.
- Cobo A, Serra V, Garrido N, Olmo I, Pellicer A, Remohi J. Obstetric and perinatal outcome of babies born from vitrified oocytes. *Fertil Steril* 2014; **102**:1006–1015.
- Devine K, Mumford SL, Goldman KN, Hodes-Wertz B, Druckenmiller S, Propst AM, Noyes N. Baby budgeting: oocyte cryopreservation in women delaying reproduction can reduce cost per live birth. *Fertil Steril* 2015; **103**:1446–1453.
- Dondorp W, de Wert G, Pennings G, Shenfield F, Devroey P, Tarlatzis B, Barri P, Diedrich K. ESHRE Task Force on Ethics and Law: oocyte cryopreservation for age-related fertility loss. *Hum Reprod* 2012; **27**:1231–1237.
- Dunson D, Colombo B, Baird D. Changes with age in the level and duration of fertility in the menstrual cycle. *Hum Reprod* 2002; **17**:1399–1403.
- Eijkemans MJC, Van Poppel F, Habbema DF, Smith KR, Leridon H, Te Velde ER. Too old to have children? Lessons from natural fertility populations. *Hum Reprod* 2014; **29**:1304–1312.
- Ferraretti AP, Goossens V, Kupka M, Bhattacharya S, de Mouzon J, Castilla JA, Erb K, Korsak V, Andersen AN, EIM, ESHRE. Assisted reproductive technology in Europe, 2009: results generated from European registers by ESHRE. *Hum Reprod* 2013; **28**:2318–2331.
- Grifo JA, Noyes N. Delivery rate using cryopreserved oocytes is comparable to conventional in vitro fertilization using fresh oocytes: potential fertility preservation for female cancer patients. *Fertil Steril* 2010; **93**:391–396.
- Hashiloni-Dolev Y, Kaplan A, Shkedi-Rafid S. The fertility myth: Israeli students' knowledge regarding age-related fertility decline and late pregnancies in an era of assisted reproduction technology. *Hum Reprod* 2011; **26**:3045–3053.
- Herrero L, Martinez M, Garcia-Velasco JA. Current status of human oocyte and embryo cryopreservation. *Obstet Gynecol* 2011; **23**:245–250.
- Hodes-Wertz B, Druckenmiller S, Smith M, Noyes N. What do reproductive-age women who undergo oocyte cryopreservation think about the process as a means to preserve fertility? *Fertil Steril* 2013; **100**:1343–1349.
- Holton S, Rowe H, Fisher J. Women's health and their childbearing expectations and outcomes: a population-based survey from Victoria, Australia. *Womens Health Issues* 2011; **21**:366–373.
- Howe GW, Vessey M, Yeates D. Effects of age, cigarette smoking, and other factors on fertility: findings in a large prospective study. *BMJ* 1985; **290**:1697–1700.
- Inhorn MC, Tjornhoj-Thomsen T, Goldberg H, Mosegaard ML. *Reconceiving the Second Sex, Men, Masculinity and Reproduction*. New York: Berghahn, 2009, 2.
- Johnson KM, Johnson DR. Partnered decisions? U.S. couples and medical help-seeking for infertility. *Fam Relat* 2009; **58**:431–444.
- Lampic C, Svanberg AS, Karlstrom P, Tyden T. Fertility awareness, intentions concerning childbearing, and attitudes towards parenthood among female and male academics. *Hum Reprod* 2006; **21**:558–564.
- Leridon H. Can assisted reproduction technology compensate for the natural decline in fertility with age? A model assessment. *Hum Reprod* 2004; **19**:1548–1553.
- Levi Setti PE, Albani E, Morengi E, Morreale G, Piane LD, Scaravelli G, Patrizio P. Comparative analysis of fetal and neonatal outcome of pregnancies from fresh and cryopreserved/thawed oocytes in the same group of patients. *Fertil Steril* 2013; **100**:396–401.
- Lundsberg LS, Pal L, Garipey AM, Xu X, Chu MC, Illuzzi JL. Knowledge, attitudes, and practices regarding conception and fertility: a population-based survey among reproductive-age United States women. *Fertil Steril* 2014; **101**:767–774.

- Menken JTJ, Larken U. Age and infertility. *Science* 1986;**233**:1389–1394.
- Mertes H, Pennings G. Social egg freezing: for better, not for worse. *Reprod Biomed Online* 2011;**23**:824–829.
- Mesen TB, Mersereau JE, Kane JB, Steiner AZ. Optimal timing for elective egg freezing. *Fertil Steril* 2015;**103**:1551–1556.
- Noyes N, Knopman JM, Melzer K, Fino ME, Friedman B, Westphal LM. Oocyte cryopreservation as a fertility preservation measure for cancer patients. *Reprod Biomed Online* 2011;**23**:323–333.
- Oktaay K, Cil AP, Bang H. Efficiency of oocyte cryopreservation: a meta-analysis. *Fertil Steril* 2006;**86**:70–80.
- Peterson BD, Pirritano M, Christensen U, Boivin J, Block J, Schmidt L. The longitudinal impact of partner coping in couples following five years of unsuccessful fertility treatments. *Hum Reprod* 2009;**24**:1656–1664.
- Peterson BD, Pirritano M, Block J, Schmidt L. Marital benefit and coping strategies in men and women undergoing unsuccessful fertility treatments over a 5-year period. *Fertil Steril* 2011;**95**:1759–1763.
- Peterson BD, Pirritano M, Tucker L, Lampic C. Fertility awareness and parenting attitudes among American male and female undergraduate university students. *Hum Reprod* 2012;**27**:1375–1382.
- Petok WD. Infertility counseling (or the lack thereof) of the forgotten male partner. *Fertil Steril* 2015;**104**:260–266.
- Rienzi L, Cobo A, Paffoni A, Scarduelli C, Capalbo A, Vajta G, Remohi J, Ragni G, Ubaldi FM. Consistent and predictable delivery rates after oocyte vitrification: an observational longitudinal cohort multicentric study. *Hum Reprod* 2012;**27**:1606–1612.
- Shimizu C, Bando H, Kato T, Mizota Y, Yamamoto S, Fujiwara Y. Physicians' knowledge, attitude, and behavior regarding fertility issues for young breast cancer patients: a national survey for breast care specialists. *Breast Cancer* 2013;**20**:230–240.
- Shkedi-Rafid S, Hashiloni-Dolev Y. Egg freezing for age-related fertility decline: preventive medicine or a further medicalization of reproduction? Analyzing the new Israeli policy. *Fertil Steril* 2011;**96**:291–294.
- Stoop D, Nekkebroeck J, Devroey P. A survey on the intentions and attitudes towards oocyte cryopreservation for non-medical reasons among women of reproductive age. *Hum Reprod* 2011;**26**:655–661.
- Stoop D, Van der Veen F, Deneyer M, Nekkebroeck J, Tournaye H. Oocyte banking for anticipated gamete exhaustion (AGE) is a preventive intervention, neither social nor nonmedical. *Reprod Biomed Online* 2014;**28**:548–551.
- Te Velde E, Pearson PL. The variability of female reproductive ageing. *Hum Reprod Update* 2002;**8**:141–154.
- Tyden T, Svanberg AS, Karlstrom PO, Lihoff L, Lampic C. Female university students' attitudes to future motherhood and their understanding about fertility. *Eur J Contracept Reprod Health Care* 2006;**11**:181–189.
- Van Loendersloot LL, Moolenaar LM, Mol BW, Repping S, van der Veen F, Goddijn M. Expanding reproductive lifespan: a cost-effectiveness study on oocyte freezing. *Hum Reprod* 2011;**26**:3054–3060.
- Virtala A, Vilska S, Huttunen T, Kunttu K. Childbearing, the desire to have children, and awareness about the impact of age on female fertility among Finnish university students. *Eur J Contracept Reprod Health Care* 2011;**16**:108–115.
- Williamson LEA, Lawson KL, Downe PJ, Pierson RA. Informed reproductive decision-making: the impact of providing fertility information on fertility knowledge and intentions to delay childbearing. *J Obstet Gynaecol Can* 2014;**36**:400–405.
- Wyndham N, Marin Figueira PG, Patrizio P. A persistent misperception: assisted reproductive technology can reverse the 'aged biological clock'. *Fertil Steril* 2012;**97**:1044–1047.