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FERTILITY PRESERVATION

Counseling patients on reproductive aging and elective fertility preservation—a survey of obstetricians and gynecologists' experience, approach, and knowledge

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Abstract

Purpose What are the experience, approach, and knowledge of US Obstetricians and Gynecologists' (ob-gyn) towards counseling patients on reproductive aging (RA) and elective fertility preservation (EFP).

Methods A cross-sectional survey emailed by the American College of Obstetricians and Gynecologists (ACOG) to 5000 ACOG fellows consisting of 9 demographic and 28 questions relating to counseling patients on RA and EFP.

Results Seven hundred and eighty-four responders completed the survey. Although 82.8% agreed that conversations relating to RA should take place with patients desiring future childbearing and delaying due to social reasons, only 27.6% stated that they frequently counsel these women aged 18–34 years old, compared to 75.8% aged 35–44 years old ($P < 0.01$). Limited time (75.8%) and limited knowledge (41.4%) were amongst the most frequent reported barriers towards counseling patients on RA. Fifty-eight percent stated that they have been asked about EFP by patients. Although 74.8% agreed that conversations should take place related to EFP in women desiring future childbearing and delaying due to social reasons, only 27.6% stated that they frequently counsel these patients on EFP ($P < 0.01$). Limited time (75%) and limited knowledge (59.9%) were amongst the most frequent barriers towards counseling on EFP.

Conclusions In the USA, methods to improve patient counseling and provider knowledge on RA and EFP are warranted and further studies are needed to address optimal methods to improve counseling and knowledge related to these topics.

Keywords Reproductive aging · Fertility preservation · Counseling · Obstetricians/gynecologists · Oocyte cryopreservation

Introduction

A woman's age and ovarian reserve are critical factors to her fertility status. The probability of a live birth decreases with advancing age due to a quantitative and qualitative decline in a woman's follicular pool [1–3]. Over the past several decades, women have increasingly delayed childbearing [4], citing social reasons including professional/educational goals, financial barriers, and lack of a partner [5–7]. Delaying childbearing makes their fecundity susceptible to the natural process of reproductive aging (RA). In a decade spanning from 2005 to 2014, there has been an approximate 64% increase in in vitro fertilization (IVF) cycles reported to the Center for Disease Control, alongside an increase in the diagnosis of diminished ovarian reserve as an etiology for IVF from 12 to 32% [8]. Unfortunately, even with the use of IVF, live birth rates per fresh IVF cycle using autologous oocytes in the USA during 2014 are below 10% in women ≥ 41 years old [9].

Fertility preservation (FP), including oocyte and embryo cryopreservation, provides a means of potentially circumventing RA. The first successful birth following embryo cryopreservation was in 1984, followed by the first birth using oocyte cryopreservation (OC) in 1986 [10]. The field of OC has advanced rapidly over the

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past several decades with studies revealing IVF success rates using OC similar to those following insemination of fresh oocytes [11–15]. Additionally, available evidence indicates that offsprings born following OC are not at increased risk of chromosomal abnormalities, congenital anomalies, or adverse obstetrical outcomes [16–20]. Success rates and safety profile of OC led to removal of the "experimental" label by the American Society for Reproductive Medicine (ASRM) in 2013 [21].

Despite the promise that elective FP (EFP) holds for women delaying childbearing, knowledge on its availability and accurate information on the effects of RA are lacking amongst reproductive aged women. Surveys from multiple countries consistently reveal that reproductive aged women underestimate the effect of fertility decline with aging and overestimate the success of assisted reproductive technologies to circumvent infertility [22–26]. This may be attributed to suboptimal counseling, as a survey of U.S. obstetrician-gynecologist (ob-gyn) residents revealed that although over 80% believe that a conversation regarding age-related fertility decline should be initiated by an ob-gyn, nearly 50% overestimated the age at which there is a marked decline in a woman's natural fertility and over 50% overestimated the success of IVF [27].

A visit to an ob-gyn during a woman's early reproductive lifespan provides an ideal opportunity to counsel on RA and, if interested, on EFP. Providing patients with accurate knowledge on these subjects will enable women to make informed decisions relating to their reproductive autonomy and maximize their reproductive potential. Thus, the focus of our study was to assess ob-gyns' experience, approach, and knowledge towards counseling patients on RA and EFP. To our knowledge, this is the first study evaluating these topics specifically amongst post-residency ob-gyns primarily practicing in the USA.

Materials and methods

Study design

This study was conducted in collaboration with the research department of the American College of Obstetricians and Gynecologists (ACOG) and was approved by the Albert Einstein College of Medicine Institutional Review Board. An email was sent via the survey platform Qualtrics to 5000 computer-generated randomly selected ACOG Fellows. This invitation to participate contained a personalized link to the survey along with an introductory paragraph describing the nature and purpose of the survey; Fellows were informed that participation was entirely voluntary and responses were anonymous. Completion of the survey was taken as implied consent. The survey was distributed over a 6-week period from October 2016 to December 2016, with an initial email followed by five weekly reminder emails sent to non-responders who had not opted-out of the study.

The survey was comprised of 37 questions, including 9 demographic questions. Questions assessed for ob-gyn approach and experience towards counseling patients on RA and EFP (embryo and/or OC), perceived barriers towards counseling patients on these subjects, and factual knowledge related to RA and OC. Questions were in a multiple-choice format and yes/no format. Some multiple-choice and yes/no questions also included an "other" choice, in which the responders were able to type an answer. The survey was constructed to be completed in less than 10 min. Responders did not have to answer all questions to complete the survey and were only allowed to complete the survey once.

The questions were compiled based on clinical experience of the authors in the fields of Obstetrics and Gynecology and Reproductive Endocrinology related to RA and EFP. Factual-based questions were derived from published data in peer-reviewed journals. A pilot survey was initially sent anonymously to a small group of practicing ob-gyns and the survey was further refined based on the results and feedback of the pilot survey.

Statistical analysis

Data were collected in an excel spreadsheet and statistical analysis was performed using STATA version 14.0. Chi square or Fisher's exact tests, as appropriate, were used to compare categorical data between groups. Logistic regression analysis was performed to identify demographic factors that affect correct responses to chosen factual questions. Cronbach's alpha value, which is used to determine internal validity of the survey, was calculated and found to be 0.79 for all questions and 0.83 after eliminating the knowledge-based questions. These values demonstrate internal validity of this survey. Continuous data are presented as mean ± standard deviation. P value < 0.05 was considered statistically significant.

Results

Of the 5000 surveys distributed, 122 opted out and 31 of the recipients had invalid emails. Amongst the remaining 4847, there were 784 responders for a response rate of 16.2%. Thirteen of those 784 responders stated that they were residents and were excluded from the analysis, for a total of 771 analyzable responders. Table 1 contains demographic characteristics of the responders. Approximately two-thirds (68.8%) of the responders were female. Average age was 47.4 ± 11.3 years old and average years out of residency were 15.0 ± 11.0 years. The majority (69.6%) described their racial/ethnic group as White with the next most frequent being Hispanic (9.1%). Most practiced either general ob-gyn or gynecology only (89.6%), with only 10.4% practicing obstetrics only. The majority did not identify with being board certified/

Table 1 Characteristics of responders

Characteristics	Number (percentage)
Gender (721)	
Male	225 (31.2)
Female	496 (68.8)
Age (718) [a]	
Up to 40 years old	252 (35.1)
41–50 years old	172(23.9)
51–60 years old	188 (26.2)
61 +	106 (14.8)
Years post-residency (711) [b]	
0–3	109 (15.3)
4–10	179 (25.2)
11–20	182 (25.6)
21–30	165 (23.2)
31 +	76 (10.7)
Racial/ethnic group (718)	
Hispanic or Latino	65 (9.0)
Asian	63 (8.8)
White	500 (69.6)
Black or African American	39 (5.4)
American Indian or Alaskan Native	4 (0.6)
Native Hawaiian or Pacific Islander	0 (0)
Mixed	25 (3.5)
Other	22 (3.1)
Which of the following do you primarily practice? (722)	
General ob-gyn	622 (86.1)
Gynecology only	25 (3.5)
Obstetrics only	75 (10.4)
Board certification in any of the following? (771)	
Reproductive endocrinology and infertility (REI)	8 (1.0)
Gynelogical/oncology	4 (0.5)
Urogynecology	5 (0.6)
Maternal fetal medicine	61 (7.9)
Other	47 (6.1)
REI + other	6 (0.8)
Mixed other	5 (0.6)
Best description of current practice structure (721)	
Solo private practice	72 (9.9)
Ob-gyn partnership group	247 (34.3)
Multi-specialty group	85 (11.8)
Hospital of clinic	120 (16.6)
University full time faculty and practice	157 (21.8)
HMO/staff model	10 (1.4)
Other	30 (4.2)
Geographic region (649)	
Northeast	114 (17.6)
Midwest	139 (21.4)
South	210 (32.3)
West	151 (23.3)
Other	35 (5.4)
Which best describes practice location (716)	
Urban inner city	177 (24.7)
Urban non-inner city	177 (24.7)
Suburban	226 (31.6)
Mid-sized town (10,000–50,000)	73 (10.2)
Rural	48 (6.7)
Military	15 (2.1)

Data are given as number of responses with percentages in parenthesis. Number entered in parenthesis following question corresponds to number of responses obtained for each question

[a] Mean ± standard deviation 47.4 ± 11.3

[b] Mean ± standard deviation 15.0 ± 11.0

eligible for subspecialties (82.5%), whereas of the 17.5% that identified as subspecialists, the most frequently identified subspecialty was maternal fetal medicine (7.9%), and only 1.8% identified as reproductive endocrinologists. The geographical distribution represented ob-gyns from all 50 US states, with the southern region being the highest represented (32.4%).

Counseling on reproductive aging

The full questionnaire is included in the Supplemental Appendix. Data pertaining to counseling patients on RA are shown in Table 2. The majority of responders (82.8%) either strongly or somewhat agreed that at some point during a woman's reproductive lifespan, a conversation should take place with her ob-gyn regarding fertility decline with aging. However, during annual exams only 27.7% of ob-gyns either most of the time or always counsel patients on RA desiring future reproduction in women aged 18–34 years old compared to 75.8% in women aged 35–44 years old ($P \leq 0.01$). When asked whether there was a specific age at which they typically begin to discuss age-related fertility decline, 51.3% responded yes with a mean age of 33.6 ± 3.1. Frequently reported minor or major barriers to counseling patients on RA were limited time (75.8%) and limited knowledge (41.5%).

When asked when a significant decline in fertility occurs, the most frequent answer was between 35 and 37 years of age (39.4%); however, 38.6% overestimated the age with 9.3% stating between 41 and 44 years old. Over half of responders overestimated the live birth success rates per cycle of IVF in women grouped into, 41–42 years old, 43–44 years old, and > 44 years old, at 57%, 52.3%, and 51.2%, respectively. The majority (87.9%) felt comfortable performing an infertility evaluation. Of those that felt comfortable, 54.8% stated that they would perform an evaluation immediately for a couple in which the woman trying to conceive is 40 years old, 45.2%

Table 2 Ob-gyn's experience, approach, and knowledge towards counseling patients on reproductive aging

Questions	Number (percentage)
Please rate the extent to which you agree or disagree with the statement: at some point during a patient's reproductive lifespan, a conversation should take place with her ob-gyn regarding fertility decline with aging (736)	
Strongly disagree	15 (2.0)
Somewhat disagree	26 (3.5)
Neither agree nor disagree	86 (11.7)
Somewhat agree	225 (30.6)
Strongly agree	384 (52.2)
How often do you encounter patients that desire future childbearing, but are delaying for social reasons (lack of partner, career goals, etc.)? (741)	
Never	12 (1.6)
Very infrequently	115 (15.5)
Somewhat infrequently	215 (29.0)
Somewhat frequently	314 (42.4)
Very frequently	85 (11.5)
During annual exams, how often do you ask women about their future reproduction/pregnancy plans if:	
They are between 18 and 34 years old? (760)	
Never	16 (2.1)
Sometimes	134 (17.6)
About half the time	90 (11.9)
Most of the time	307 (40.4)
Always	213 (28.0)
They are between 35 and 44 years old? (759)	
Never	19 (2.5)
Sometimes	131 (17.3)
About half the time	108 (14.2)
Most of the time	297 (39.1)
Always	204 (26.9)
Based on your current practice, how often do you counsel women who desire future childbearing on age-related fertility decline if:	
They are between 18 and 34 years old? (755)	
Never	86 (11.4)
Sometimes	330 (43.7)
About half the time	130 (17.2)
Most of the time	152 (20.1)
Always	57 (7.6)
They are between 35 and 44 years old? (758)	
Never	22 (2.9)
Sometimes	94 (12.4)
About half the time	68 (8.9)
Most of the time	284 (37.5)
Always	290 (38.3)
Is there a specific age at which you typically begin to discuss age-related fertility decline? (756)	
No	356 (47.1)
Yes (please specify): _____	388 (51.3)
N/A I do not bring up fertility decline with aging	12 (1.6)
Those that responded yes (388)	Mean = 33.6 ± 3.1 years old * Bottom 10th % range—25–30 years old Top 10th % range—37–50 years old
In your practice, what are the barriers to counseling patients on reproductive aging? Limited time (732)	
Not a barrier	177 (24.2)
Minor barrier	321 (43.9)
Major barrier	234 (31.9)
Limited knowledge (726)	
Not a barrier	425 (58.5)
Minor barrier	261 (36.0)
Major barrier	40 (5.5)
Limited training (725)	
Not a barrier	414 (57.1)
Minor barrier	273 (37.7)
Major barrier	38 (5.2)
It contradicts with my personal beliefs (726)	
Not a barrier	697 (96)
Minor barrier	21 (2.9)
Major barrier	8 (1.1)
Discomfort bringing it up with patients (728)	
Not a barrier	634 (87.1)
Minor barrier	82 (11.3)
Major barrier	12 (1.6)
Other please specify (71) _____	
A significant decline in fertility occurs during which age range? (737)	
20–29	15 (2.0)
30–34	148 (20.1)
35–37 **	290 (39.3)
38–40	216 (29.3)
41–42	52 (7.1)
43–44	16 (2.2)
For couples presenting to your office with infertility, do you feel comfortable performing an infertility evaluation? (734)	
Yes	645 (87.9)
No (skip next question)	89 (12.1)
Approximately how long do you typically wait for a couple to try to conceive before performing an infertility workup, when the women trying to conceive is:	
35 years old (645)	
Immediately	55 (8.5)
3 months	74 (11.5)
6 months	466 (72.3)
9 months	28 (4.3)
12 months or more	22 (3.4)
40 years old (642)	
Immediately	352 (54.8)

Table 2 (continued)

Questions	Number (percentage)
3 months	143 (22.3)
6 months	139 (21.7)
9 months	4 (0.6)
12 months or more	4 (0.6)
Following in vitro fertilization (IVF) for patients _____ years old, live birth rates per cycle are approximately _____ (718)	
41–42 years old (718)	
1%	9 (1.3)
5%	95 (13.2)
10% **	205 (28.5)
20%	194 (27.0)
30%	138 (19.2)
40%	55 (7.7)
50%	22 (3.1)
43–44 years old (716)	
1%	103 (14.4)
5% **	239 (33.4)
10%	176 (24.6)
20%	120 (16.8)
30%	58 (8.1)
40%	16 (2.2)
50%	4 (0.5)
> 44 years old (717)	
1% **	349 (48.7)
5%	183 (25.5)
10%	102 (14.3)
20%	61 (8.5)
30%	20 (2.8)
40%	1 (0.1)
50%	1 (0.1)

Data are given as number of responses with percentages in parenthesis. Number entered in parenthesis following question corresponds to number of responses obtained for each question

*Mean ± standard deviation

**Denotes correct answer based on published literature

stated that they would wait 3 months or longer, and 22.9% stated that they would wait 6 months or longer.

Counseling on elective fertility preservation

Selected data pertaining to counseling patients on EFP are shown in Table 3. Full questions and responses related to questions on EFP are listed in Supplementary table I. Most responders (74.8%) believed a conversation should take place regarding EFP in patients delaying pregnancy due to social reasons; however, in practice, only 27.6% stated that they counsel them most of the time or always. When given a clinical scenario of a reproductive age women desiring future childbearing who will undergo gonadotoxic treatment, 90.4% stated that they would likely counsel her on FP; in contrast, only 55.5% indicated that they would likely counsel patients desiring future childbearing who were delaying for social reasons ($P < 0.01$). Twenty-seven percent stated that there is a specific age at which they bring up EFP with patients, with a mean age of 34.2 years old ± 2.8, and the top 10% range being 38–40 years old. Additionally, 58.1% stated that they have been asked by patients about FP. Of those that have been asked, over half (56.1%) stated that they were asked quarterly or more frequently, and 22.9% stated monthly or more frequently. The most common barrier to counseling on FP was limited time (75%), followed by limited training and knowledge (61.2 and 59.9%, respectively). An opportunity was given to free text additional barriers to counseling patients on FP (data not shown). Ninety-seven responses were given, with the most frequent answer (74.2%) relating to high cost. Over half (52.2%) were unaware that OC was not considered experimental by ASRM and 51.3% believed that, based on available data, risk for congenital anomalies for babies born from oocyte cryopreservation were at similar risk compared to the general population. Approximately 25% believed that they were at increased risk for congenital anomalies and 21.3% were unsure.

Correlation between male and female responders, years out of residency, and answers to factual questions

Answers for factual questions were compared amongst male and female responders, and years out of residency, categorized by 0–3, 4–10, 11–20, 21–30, and over 31 years (Supplementary table II). Correct answers related to IVF success rates were given by significantly more woman compared to men ($P < 0.01$). Additionally, for the question related to the age at which a significant decline in fertility occurs, there was a significant difference in correct responses categorized by year out of residency ($P = 0.04$) and in women compared to men ($P < 0.01$); however, when logistic regression analysis was performed controlling for sex of responders, years out of residency was not correlated to the knowledge of age at which significant decline in fertility occurs.

Discussion

As primary providers of women's healthcare during their reproductive years, ob-gyns' experience, approach, and knowledge towards counseling patients on RA and EFP are crucial to evaluate. The vast majority of responders stated that they practiced either gynecology only or general ob-gyn, which represents the ideal provider to counsel women on RA and

Table 3 Ob-gyn's experience, approach, and knowledge towards counseling patients on elective fertility preservation

Questions	Number (percentage)
For patients of reproductive age who delay childbearing due to social reasons (lack of partner, career goals, etc.), a conversation should take place with her ob-gyn regarding the availability of fertility preservation (egg and/or embryo freezing) (737)	
Strongly disagree	12 (1.6)
Somewhat disagree	44 (6.0)
Neither agree nor disagree	130 (17.6)
Somewhat agree	276 (37.5)
Strongly agree	275 (37.3)
Have patients asked about fertility preservation? (740)	
No (skip question)	310 (41.9)
Yes	430 (58.1)
Approximately how often have you been asked about fertility preservation (egg and/or embryo freezing), in the past 3 years? (431)	
Weekly	17 (4.0)
Monthly	82 (19.0)
Quarterly	143 (33.2)
Semi-annually	113 (26.2)
Yearly	76 (17.6)
Is there a specific age at which you typically begin to bring up fertility preservation (egg and/or embryo freezing)? (739)	
No	485 (65.6)
Yes	205 (27.8)
N/A I do not bring up fertility preservation with patients	49 (6.6)
Those that responded yes (185)	34.2 ± 2.8 years old * Bottom 10th% range—26–30 years old Top 10th % range—38–40 years old
In your practice, what are the barriers to counseling patients on fertility preservation (egg and/or embryo freezing)?	
Limited time (725)	
Not a barrier	182 (25.1)
Minor barrier	298 (41.1)
Major barrier	245 (33.8)
Limited knowledge (721)	
Not a barrier	289 (40.1)
Minor barrier	312 (43.3)
Major barrier	120 (16.6)
Limited training (717)	
Not a barrier	278 (38.8)
Minor barrier	330 (46.0)
Major barrier	109 (15.2)
It contradicts with my personal beliefs (722)	
Not a barrier	683 (94.6)
Minor barrier	25 (3.5)
Major barrier	14 (1.9)
Discomfort bringing it up with patients (721)	
Not a barrier	631 (87.5)
Minor barrier	76 (10.6)
Major barrier	14 (1.9)
New and experimental nature of oocyte cryopreservation (721)	
Not a barrier	373 (51.7)
Minor barrier	240 (33.3)
Major barrier	108 (15.0)
Other please specify (97) _____	
Is oocyte cryopreservation considered experimental according to the American Society for reproductive medicine? (735)	
No **	351 (47.8)
Yes	56 (7.6)
Unsure	328 (44.6)

Data are given as number of responses with percentages in parenthesis. Number entered in parenthesis following question corresponds to number of responses obtained for each question

*Mean ± standard deviation

**Denotes correct answer based on published literature

EFP. Consistent with recent sociological trends in delaying childbirth [4], slightly over half of responders stated that they frequently encounter patients desiring childbearing, however, delaying due to social reasons. It is reassuring that a large majority of ob-gyns in this survey agree that at some point in a woman's reproductive lifespan, a conversation should take place with her ob-gyn regarding RA. This is consistent with a study evaluating residents' attitudes towards counseling patients on RA, as 83% of surveyed US residents believed that an ob-gyn should initiate a discussion relating to age-related fertility decline [27]. Counseling patients on RA is of great importance to a woman's reproductive autonomy as studies from many countries have consistently shown that accurate fertility knowledge is lacking amongst reproductive aged women [22, 24–26, 28], as highlighted in a study of over 10,000 reproductive age men and women from 79 countries with average score of 51.9% on a fertility knowledge questionnaire [29].

Although a large percentage of responders agree that at some point during a woman's reproductive lifespan, a conversation should take place regarding RA, actual practice may not be reflective of their beliefs, which may be explained by the age of the patient. A significant discrepancy was reported between the ages at which responders would most of the time or always counsel women on RA at 35–44 years old compared to 18–34 years old (75.8 vs. 27.7%, respectively). These discrepant findings may reflect the broad age range of 18–34 years old used in this survey, as approximately half surveyed stated that there was a specific age they would bring up

RA, with a mean age of 33.6 ± 3.1 years old. With that stated, it is important that patients obtain counseling on RA during their peak reproductive potential and prior to when a steep decline in fecundity occurs, on average in mid to late 20's and 35–37 years old, respectively [30–37]. Women at risk for an accelerated decline in fertility warrant earlier counseling particularly in patients with a family history of premature ovarian insufficiency, fragile X premutation, history of chemotherapy or pelvic radiation, severe endometriosis, history of ovarian surgery, history of pelvic infection, and heavy smoking [38–42].

In light of current demands in medical practice, it is no surprise that an overwhelming majority of responders reported time as a barrier to counseling patients on RA. It may be best to set up a separate counseling session or refer to a reproductive endocrinologist for appropriate counseling. A thorough counseling session on RA should include increased risks of pregnancy complications in older mothers including preeclampsia, preterm birth, low birth weight, placenta previa, cesarean section, increased risk of chromosomal abnormalities, and increased risk of miscarriage [43–46]. In light of time constraints, a dedicated clinic to discuss factors related to protecting fertility could be of benefit. A fertility assessment and counseling clinic in Denmark has been established specifically with the aim of protecting fertility in patients not currently struggling with infertility [47]. An initial evaluation of patients attending this clinic revealed that 99% of women found it useful and 70% wanted estimates on years available to postpone motherhood. Curiously, 35% stated that they would advance the decision to become pregnant following consultation [47]. Although generally not covered by insurance, OC has been proven cost-effective in women delaying their childbearing to their late reproductive years. A mathematical model revealed that OC performed by age 37 years old would be more cost-effective than no action [48], whereas another model revealed it to be cost-effective by 35 years old [49].

Limited knowledge was another frequently reported barrier towards counseling on RA and EFP, at 41.4 and 59.9%, respectively. Consistent with self-reported limited knowledge, more than half of the responders were unaware that OC is not considered experimental by ASRM [21] and slightly over one third overestimated the age at which a significant decline in fertility occurs.

A common misconception is that IVF can circumvent a woman's natural decline in fertility that occurs in the 5th decade of life [50]. In the USA, live birth rates per cycle of IVF reported to the CDC in 2014 using autologous oocytes were 37.1% in women younger than 35 years old, decreasing to 9.7% in women 41–42 years old, 3.8% in 43–44 years old, and 1.2% in women over 44 years old [9]. Our survey demonstrated that ob-gyns overestimate the success of IVF in women over 40 years old, with over 50% overestimating IVF success rates in women aged 41–42, 43–44, and over 44 years old. Additionally, the majority of responders stated that they felt comfortable performing an infertility evaluation; however, of those that felt comfortable, 45.2% would wait 3 or more months and 22.9% would wait 6 months before performing an infertility evaluation in a couple in which the women is 40 years old. This delay in evaluation for women over 40 years old is consistent with underestimating the marked decline in fertility that occurs as a woman enters her 5th decade of life. Indeed, ACOG and ASRM recommend immediate infertility evaluation in women attempting to conceive older than 40 years old [35].

Embryo and/or OC have been proposed as a method to circumvent RA. A major benefit of OC over embryo cryopreservation is the absence of a need for a suitable partner, which is a reason commonly cited by women to delay childbearing [5, 51, 52]. Despite its availability, many reproductive aged women are unfamiliar with OC [53]. Although the majority of responders believe that a conversation should take place regarding EFP in patients delaying childbearing for social reasons, in practice only, a little more than a quarter stated that they counsel these patients most of the time or always. The discrepancy may be age-related as the question did not specify an age; however, when asked if there was a specific age at which they bring up FP, only a little more than a quarter stated yes, with the average age of 34.2 ± 2.8 years old. These findings are consistent with a study revealing that only 25% of women undergoing elective OC (EOC) learned about the technology from their ob-gyn [5], with 79% stating that they wished they had undergone EOC at an earlier age [5]. Patient knowledge relating to the availability of EFP may be shifting as over half of responders have been asked by patients about EFP; of those that did, nearly one quarter have been asked on a monthly or greater basis.

The main limitations of this study include the relatively low response rate and use of an unvalidated survey. The low response rate can introduce bias and thus the results may not accurately represent the views of US ob-gyns related to counseling patients on RA and EFP. Additionally, demographics related to non-responders are not available and therefore, comparisons of demographics and baseline characteristics between responders and non-responders cannot be made. Although the magnitude of this bias cannot be assessed, this is the first study of its kind and provides very important information that can be used to improve counseling methods related to RA and EFP. Cronbach's alpha was calculated as 0.79 when incorporating all questions, indicating an acceptable level of reliability and internal consistency of the questionnaire [54]. Further studies from a sample known to represent US ob-gyns' demographics/characteristics may be of value to further evaluate the experience, approach, and knowledge related to counseling patients on RA and EFP.

In conclusion, this is the first US survey specifically targeting post-residency ob-gyns on their experience, approach, and knowledge towards counseling patients on RA and EFP. Findings from this study indicate that a large majority of ob-gyns believe that counseling patients on RA and EFP is important, however, in practice fewer counsel. This may be related to limited time and knowledge constraints, indicating the need for improved counseling methods. Empowering women with accurate information relating to RA and EFP will help guide them make the most appropriate decisions regarding their reproductive potential. The past half-century has seen a revolutionary change in reproductive autonomy with easy access to contraception and legalization of abortion; however, with sociological norms shifting to delayed childbearing, an integral component of a woman's reproductive autonomy and choice is to arm her with information relating to RA so that she can make pro-fertility decisions regarding her reproductive future.

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References

1. Block E. Quantitative morphological investigations of the follicular system in women; variations at different ages. Acta Anat (Basel). 1952;14(1–2):108–23.
2. Baker TG. A quantitative and cytological study of germ cells in human ovaries. Proc R Soc Lond B Biol Sci. 1963;158:417–33.
3. Pellestor F, Andreo B, Arnal F, Humeau C, Demaille J. Maternal aging and chromosomal abnormalities: new data drawn from in vitro unfertilized human oocytes. Hum Genet. 2003;112(2):195–203. https://doi.org/10.1007/s00439-002-0852-x.
4. Martin JA, Hamilton BE, Osterman MJ, Driscoll AK, Mathews TJ. Births: final data for 2015. Natl Vital Stat Rep. 2017;66(1):1.
5. 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(5):1343–9. https://doi.org/10.1016/j.fertnstert.2013.07.201.
6. Heck KE, Schoendorf KC, Ventura SJ, Kiely JL. Delayed childbearing by education level in the United States, 1969-1994. Matern Child Health J. 1997;1(2):81–8.
7. Hammarberg K, Clarke VE. Reasons for delaying childbearing–a survey of women aged over 35 years seeking assisted reproductive technology. Aust Fam Physician. 2005;34(3):187–8. 206
8. Centers for Disease Control and Prevention. 2016. https://www.cdc.gov/art/reports/archive.html. Accessed 3/13/2017 2017.
9. Centers for Disease Control and Prevention. https://www.cdc.gov/art/reports/2014/national-summary.html. Accessed 3/13/2017 2017.
10. Chen C. Pregnancy after human oocyte cryopreservation. Lancet. 1986;1(8486):884–6.
11. 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(2):391–6. https://doi.org/10.1016/j.fertnstert.2009.02.067.
12. Trokoudes KM, Pavlides C, Zhang X. Comparison outcome of fresh and vitrified donor oocytes in an egg-sharing donation program. Fertil Steril. 2011;95(6):1996–2000. https://doi.org/10.1016/j.fertnstert.2011.02.035.
13. Cobo A, Diaz C. Clinical application of oocyte vitrification: a systematic review and meta-analysis of randomized controlled trials. Fertil Steril. 2011;96(2):277–85. https://doi.org/10.1016/j.fertnstert.2011.06.030.
14. Rienzi L, Romano S, Albricci L, Maggiulli R, Capalbo A, Baroni E, et al. Embryo development of fresh 'versus' vitrified metaphase II oocytes after ICSI: a prospective randomized sibling-oocyte study. Hum Reprod. 2010;25(1):66–73. https://doi.org/10.1093/humrep/dep346.
15. Cobo A, Meseguer M, Remohi J, Pellicer A. Use of cryo-banked oocytes in an ovum donation programme: a prospective, randomized, controlled, clinical trial. Hum Reprod. 2010;25(9):2239–46. https://doi.org/10.1093/humrep/deq146.
16. Cobo A, Rubio C, Gerli S, Ruiz A, Pellicer A, Remohi J. Use of fluorescence in situ hybridization to assess the chromosomal status of embryos obtained from cryopreserved oocytes. Fertil Steril. 2001;75(2):354–60.
17. Noyes N, Porcu E, Borini A. Over 900 oocyte cryopreservation babies born with no apparent increase in congenital anomalies. Reprod BioMed Online. 2009;18(6):769–76.
18. Goldman KN, Kramer Y, Hodes-Wertz B, Noyes N, McCaffrey C, Grifo JA. Long-term cryopreservation of human oocytes does not increase embryonic aneuploidy. Fertil Steril. 2015;103(3):662–8. https://doi.org/10.1016/j.fertnstert.2014.11.025.
19. 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(4):1006–15 e4. https://doi.org/10.1016/j.fertnstert.2014.06.019.
20. Chian RC, Huang JY, Tan SL, Lucena E, Saa A, Rojas A, et al. Obstetric and perinatal outcome in 200 infants conceived from vitrified oocytes. Reprod BioMed Online. 2008;16(5):608–10.
21. Practice Committees of American Society for Reproductive M, Society for Assisted Reproductive T. Mature oocyte cryopreservation: a guideline. Fertil Steril. 2013;99(1):37–43. https://doi.org/10.1016/j.fertnstert.2012.09.028.
22. 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(5):1375–82. https://doi.org/10.1093/humrep/des011.
23. 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(2):108–15. https://doi.org/10.3109/13625187.2011.553295.
24. 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(11):3045–53. https://doi.org/10.1093/humrep/der304.
25. 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(2):364–72. https://doi.org/10.1093/humrep/deu324.
26. 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(7):2162–8. https://doi.org/10.1016/j.fertnstert.2009.01.064.
27. Yu L, Peterson B, Inhorn MC, Boehm JK, Patrizio P. Knowledge, attitudes, and intentions toward fertility awareness and oocyte

cryopreservation among obstetrics and gynecology resident physicians. Hum Reprod. 2016;31(2):403–11. https://doi.org/10.1093/humrep/dev308.
28. Lundsberg LS, Pal L, Gariepy 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(3):767–74. https://doi.org/10.1016/j.fertnstert.2013.12.006.
29. Bunting L, Tsibulsky I, Boivin J. Fertility knowledge and beliefs about fertility treatment: findings from the international fertility decision-making study. Hum Reprod. 2013;28(2):385–97. https://doi.org/10.1093/humrep/des402.
30. Dunson DB, Baird DD, Colombo B. Increased infertility with age in men and women. Obstet Gynecol. 2004;103(1):51–6. https://doi.org/10.1097/01.AOG.0000100153.24061.45.
31. Howe G, Westhoff C, Vessey M, Yeates D. Effects of age, cigarette smoking, and other factors on fertility: findings in a large prospective study. Br Med J (Clin Res Ed). 1985;290(6483):1697–700.
32. Stovall DW, Toma SK, Hammond MG, Talbert LM. The effect of age on female fecundity. Obstet Gynecol. 1991;77(1):33–6.
33. Maroulis G. Effects of aging on fertility and pregnancy. Seminars in Reproductive Aging. 9(3):165–74.
34. Schwartz D, Mayaux MJ. Female fecundity as a function of age: results of artificial insemination in 2193 nulliparous women with azoospermic husbands. Federation CECOS. N Engl J Med. 1982;306(7):404–6. https://doi.org/10.1056/NEJM198202183060706.
35. American College of Obstetricians and Gynecologists Committee on Gynecologic Practice and Practice Committee. Female age-related fertility decline. Committee opinion no. 589. Fertil Steril. 2014;101(3):633–4. https://doi.org/10.1016/j.fertnstert.2013.12.032.
36. Dunson DB, Colombo B, Baird DD. Changes with age in the level and duration of fertility in the menstrual cycle. Hum Reprod. 2002;17(5):1399–403.
37. Steiner AZ, Jukic AM. Impact of female age and nulligravidity on fecundity in an older reproductive age cohort. Fertil Steril. 2016;105(6):1584–8 e1. https://doi.org/10.1016/j.fertnstert.2016.02.028.
38. Cramer DW, Xu H, Harlow BL. Family history as a predictor of early menopause. Fertil Steril. 1995;64(4):740–5.
39. Schattman GL, Clinical Practice. Cryopreservation of Oocytes. N Engl J Med. 2015;373(18):1755–60. https://doi.org/10.1056/NEJMcp1307341.
40. Augood C, Duckitt K, Templeton AA. Smoking and female infertility: a systematic review and meta-analysis. Hum Reprod. 1998;13(6):1532–9.
41. Barnhart K, Dunsmoor-Su R, Coutifaris C. Effect of endometriosis on in vitro fertilization. Fertil Steril. 2002;77(6):1148–55.
42. American College of Obstetricians and Gynecologists Committee on Gynecologic Practice and Practice Committee of the American Society for Reproductive Medicine. Female age-related fertility decline. Committee opinion no. 589. Obstet Gynecol. 2014;123(3):719–21. https://doi.org/10.1097/01.AOG.0000444440.96486.61.
43. Hoffman MC, Jeffers S, Carter J, Duthely L, Cotter A, Gonzalez-Quintero VH. Pregnancy at or beyond age 40 years is associated with an increased risk of fetal death and other adverse outcomes. Am J Obstet Gynecol. 2007;196(5):e11–3. https://doi.org/10.1016/j.ajog.2006.10.862.
44. Forrester MB, Merz RD. Maternal age-specific down syndrome rates by maternal race/ethnicity, Hawaii, 1986-2000. Birth Defects Res A Clin Mol Teratol. 2003;67(9):625–9. https://doi.org/10.1002/bdra.10112.
45. Cleary-Goldman J, Malone FD, Vidaver J, Ball RH, Nyberg DA, Comstock CH, et al. Impact of maternal age on obstetric outcome. Obstet Gynecol. 2005;105(5 Pt 1):983–90. https://doi.org/10.1097/01.AOG.0000158118.75532.51.
46. Nybo Andersen AM, Wohlfahrt J, Christens P, Olsen J, Melbye M. Maternal age and fetal loss: population based register linkage study. BMJ. 2000;320(7251):1708–12.
47. Hvidman HW, Petersen KB, Larsen EC, Macklon KT, Pinborg A, Nyboe AA. Individual fertility assessment and pro-fertility counselling; should this be offered to women and men of reproductive age? Hum Reprod. 2015;30(1):9–15. https://doi.org/10.1093/humrep/deu305.
48. Mesen TB, Mersereau JE, Kane JB, Steiner AZ. Optimal timing for elective egg freezing. Fertil Steril. 2015;103(6):1551–6 e1-4. https://doi.org/10.1016/j.fertnstert.2015.03.002.
49. 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(11):3054–60. https://doi.org/10.1093/humrep/der284.
50. Wyndham N, Marin Figueira PG, Patrizio P. A persistent misperception: assisted reproductive technology can reverse the "aged biological clock". Fertil Steril. 2012;97(5):1044–7. https://doi.org/10.1016/j.fertnstert.2012.02.015.
51. Benzies K, Tough S, Tofflemire K, Frick C, Faber A, Newburn-Cook C. Factors influencing women's decisions about timing of motherhood. J Obstet Gynecol Neonatal Nurs. 2006;35(5):625–33. https://doi.org/10.1111/j.1552-6909.2006.00079.x.
52. Tough S, Tofflemire K, Benzies K, Fraser-Lee N, Newburn-Cook C. Factors influencing childbearing decisions and knowledge of perinatal risks among Canadian men and women. Matern Child Health J. 2007;11(2):189–98. https://doi.org/10.1007/s10995-006-0156-1.
53. Tan SQ, Tan AW, Lau MS, Tan HH, Nadarajah S. Social oocyte freezing: a survey among Singaporean female medical students. J Obstet Gynaecol Res. 2014;40(5):1345–52. https://doi.org/10.1111/jog.12347.
54. Tavakol M, Dennick R. Making sense of Cronbach's alpha. Int J Med Educ. 2011;2:53–5. https://doi.org/10.5116/ijme.4dfb.8dfd.