

Fertility awareness and parenting attitudes among American male and female undergraduate university students

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BACKGROUND: In the USA, the postponement of childbearing reflects contemporary social norms of delaying marriage, pursuing educational goals and securing economic stability prior to attempting conception. Although university students are more likely to delay childbearing, it is unclear to what extent they are aware of age-related fertility decline. The current study is the first of its kind to assess fertility awareness and parenting attitudes of American undergraduate university students.

METHODS: Two-hundred forty-six randomly selected undergraduate university students (138 females and 108 males) completed an online self-report survey adapted from the Swedish Fertility Awareness Questionnaire. Students were evenly distributed between the freshman, sophomore, junior and senior classes with a mean age of 20.4 years.

RESULTS: Participants wanted to have their first and last child within the window of a woman's fertility. However, participants demonstrated a lack of fertility awareness by vastly overestimating the age at which women experience declines in fertility, the likelihood of pregnancy following unprotected intercourse and the chances that IVF treatments would be successful in the case of infertility. Nearly 9 in 10 participants want to have children in the future and viewed parenthood as a highly important aspect of their future lives.

CONCLUSIONS: Delaying childbearing based on incorrect perceptions of female fertility could lead to involuntary childlessness. Education regarding fertility issues is necessary to help men and women make informed reproductive decisions that are based on accurate information rather than incorrect perceptions.

Key words: fertility awareness / involuntary childlessness / parenthood / attitudes / university students

Introduction

In the USA, the proportion of first births to women at ages 35–39 has increased 50% over the past two decades (Martin *et al.*, 2009). The average age of first-time mothers in the USA is 25.0 years, an increase from 21.4 years in 1970 (Mathews and Hamilton, 2009). Approximately 1 in 12 first births in 2006 were to women at ages 35 or older, a figure eight times larger than in 1970 when the rate of first births to these women was 1 in 100 (Mathews and Hamilton, 2009). The trend to delay childbearing in the USA is particularly evident among college educated women (Heck *et al.*, 1997).

The postponement of childbearing reflects contemporary social norms of delaying marriage, pursuing educational goals and securing economic stability prior to attempting conception (Heck, *et al.*, 1997; Benzie *et al.*, 2006; Tyden *et al.*, 2006; Bretherick *et al.*, 2010; Cooke *et al.*, in press). However, it is unclear to what extent women and men are aware of age-related fertility decline (Lampic *et al.*, 2006). For women, fertility begins to decline in the late twenties and rapidly declines between ages 35 and 37, primarily because of decreased quality and quantity of oocytes and an increase in the rate of miscarriage (Menken *et al.*, 1986; Dunson *et al.*, 2002; American Society for Reproductive Medicine, 2003; Madankumar *et al.*,

2003). Advanced maternal age at first birth is also associated with increased rates of obstetric complications including preterm delivery, multiple births, low birthweight and stillbirth (Heck et al., 1997; Tough et al., 2007; Schmidt et al., 2012).

There is a growing body of research indicating a significant underestimation of the impact age has on fertility, particularly among women pursuing higher education (Lampic et al., 2006; Virtala et al., 2011). In addition, recent studies have found that there is a general lack of awareness among women regarding the risks of delayed child-bearing (Tough et al., 2007; Cooke et al., 2010), and many falsely believe that advanced reproductive treatments such as IVF will overcome fertility problems associated with age (Lampic et al., 2006; Maheshwari et al., 2008; Bretherick et al., 2010).

There are relatively few studies which have examined the fertility awareness of men and women seeking higher education—a group that is particularly at risk for involuntary childlessness due to pursuit of educational and career activities (Tyden et al., 2006). Three Swedish studies (Lampic et al., 2006; Skoog Svanberg et al., 2006; Tyden et al., 2006), two Finnish studies (Virtala et al., 2006, 2011), two Canadian studies (Tough et al., 2007; Bretherick et al., 2010), one Italian study (Rovei, et al., 2010) and one Israeli study (Hashiloni-Dolev et al., 2011) have begun this important line of inquiry. Lampic et al. (2006) found that university students planned to have their children at ages when female fertility has decreased, without being sufficiently aware of age-related fertility decline. Other studies reported that knowledge about human fertility in university students was generally poor (Skoog Svanberg et al., 2006; Rovei et al., 2010; Virtala et al., 2011), and that women significantly overestimated their chance of pregnancy at all ages and were unaware of the steep decline in fertility at the correct ages (Bretherick et al., 2010).

Couples who unknowingly delay pregnancy past a woman's window of fertility may be faced with involuntary childlessness. This unexpected event can lead to significant alterations in a couple's family and social networks, strain on the marital relationship and emotional as well as physical challenges associated with fertility treatments (Peterson et al., 2009; Greil et al., 2010). While assisted reproductive technologies (ARTs) can be effective, men and women overestimate the likelihood that they will solve the fertility problems they may experience (Lampic et al., 2006; Skoog Svanberg et al., 2006), and only half of the births lost by postponing a first attempt to conceive from age 30 to 35 can be compensated for by these technologies (Leridon, 2004). Furthermore, although success rates have improved over time, the average live birth rate per cycle of IVF, using fresh non-donor eggs, in the USA is 30%, with a success rate of 18% for women at the age of 40, and only 3% for women at the age of 44 (Center for Disease Control and Prevention, 2008).

The purpose of the current study was to build on previous international research examining fertility awareness using an American sample of male and female undergraduate university students. It was conducted in response to calls to assess fertility awareness and increase education in men and women who desire parenthood so these individuals can make more informed reproductive decisions (Madankumar et al., 2003; Sobotka, 2006; The Committee on Gynecologic Practice of the American College of Obstetrics and Gynecologists and The Practice Committee of the American Society for Reproductive Medicine, 2008; Cooke et al., 2010). The current study aimed to assess undergraduate students' intentions and attitudes

towards future parenthood, as well as their awareness of human reproduction and age-related fertility decline. To the authors' knowledge, this is the first study to examine this issue in an undergraduate sample of American university students.

Materials and Methods

Participants and procedures

The present study was approved by a university based Institutional Review Board (IRB). Four hundred female and 400 male students were randomly selected from the undergraduate student body of a private university in the western USA. Students were contacted by email and were invited to participate in the study by completing an online survey on fertility awareness and parenting attitudes. As an incentive, students who completed the survey were entered into a lottery to win one of three \$50 gift certificates to the Apple store. Men and women were contacted in separate emails that contained a URL link to the gender-specific study measure. Only students who were active registrants at the university at the time of implementation were 18 years of age or older, and agreed to the informed consent could participate in the study.

One hundred and forty females and 108 males completed the data collection instrument for a final response rate of 31%. The majority of participants (77%) responded within 1 week of the initial contact. A second follow-up email which was sent 3 weeks following the first contact yielded an additional 23% of participants. Data from two female students were not included in the study because one did not agree to the informed consent statement and the other did not indicate that she was at least 18 years old. The final sample included 246 undergraduate students [$n = 138$ female (54%) and $n = 108$ male (46%)].

Measures

The study used a questionnaire developed by Lampic et al. (2006) as the basis for data collection. The instrument, reported to have satisfactory face validity and reliability, was translated into English and included four domains. *Awareness of fertility issues* (9 items) was assessed by questions regarding women's fertility and chances of pregnancy and infertility. An open response format was used for this section of the instrument. The *Intentions to have children domain* (4 items) included one question on plans to have children (Yes/No) and three questions on the desired number of children and age at parenthood (open response format). *Importance of having children* (1 item) and *behavioral intentions in case of infertility* (3 items) were assessed with 0–10 point response scales with the end-points Unimportant/extremely important and entirely unlikely/highly likely, respectively. All items and response scales were identical to the prior study (Lampic et al., 2006) except for those using a visual analogue scale that could not be replicated due to online survey limitations. As a comparable alternative, the current study used a 0–10 point response scale for questions assessing the importance of parenthood and intentions in the event of infertility. Responses to questions with an open response format were categorized according to the same principles as in the study by Lampic et al. (2006) (see details in Data analyses section).

For the current study, four questions were added to the original instrument. The first question used a 5-point Likert scale to assess how educated participants believed they were regarding fertility issues, with categories ranging between 'Not at all educated' and 'Very educated'. The second question asked participants to indicate where they had gained most of their knowledge regarding fertility issues. Students could select one category from a list including family, friends, doctor/gynecologist, school, media and other. The third question used a 5-point Likert

scale to indicate how confident participants were that they would have the number of children they wanted at the ages they desired, with scores ranging from 'Not at all confident' to 'Very confident'. Finally, participants were asked about potential obstacles they believed may prevent them from having the number of children they wanted at the ages they desired. Students could select multiple categories which included career aspirations, educational goals, personal interests, not finding the right partner, not feeling emotionally ready, financial concerns and infertility.

Data analyses

For responses using 5-point Likert-type scales and 0–10 point response items, men and women were compared using the Mann–Whitney *U*-test. Differences between men and women for variables that represent count data were analyzed using the χ^2 test. Continuous data from open responses regarding awareness of fertility issues were categorized into age periods or level of percentage. Responses for each question formed four categories, one of which constitutes the 'correct answer' based on published data (von Noord-Zaadstra *et al.*, 1991; Zinaman *et al.*, 1996; Dunson *et al.*, 2002; Van Voorhis, 2007; Center for Disease Control and Prevention, 2008). While the 'correct answer' and at least one additional category are presented in segments of 5 years or 10%, the boundaries of remaining categories may entail larger segments since they are based on open responses. The criteria for determining the statistical significance of a test was $P < 0.05$. The software package IBM SPSS Statistics Version 19 was used for all analyses.

Results

Sample characteristics

Table 1 presents the sample characteristics of study participants. One hundred thirty-eight women (54%) and 108 men (46%) participated in the study. The average age of participants was 20.4 years ($SD = 2.3$). Students were evenly distributed between the freshman, sophomore, junior and senior classes. None of the study participants had a child. Nearly three-quarters (73%) of the sample were White, 11% Asian, 5% Hispanic/Latino, 3% African American, 1% Middle Eastern and 7% other. Fifty-eight percent of the participants were single, 38% were in a committed relationship, 1% were married and 1% were engaged. Women were more likely than men to be in a committed relationship (42 versus 33%, $\chi^2 = 4.85$, $P = .03$).

To assess for potential response bias due to the response rate, we compared respondents with non-respondents on basic demographic variables. Respondents and non-respondents did not significantly differ on their mean age or mean numbers of years in school, however, male respondents were more likely to be White when compared with male non-respondents ($\chi^2(5) = 12.2$, $P = 0.03$). There was also a statistically significant difference in the ethnic composition of respondents compared with the overall university population ($\chi^2(5) = 30.4$, $P = 0.001$). There were fewer Hispanic/Latino and more White students in the sample than would be predicted by the proportion of these ethnicities in the overall student body.

Table 1 Demographics.

	Women (n = 138)		Men (n = 108)		Gender difference (P)
Age (years), mean (SD)	20.3 (2.0)		20.7 (2.6)		0.16
Year in school, mean (SD)	2.4 (1.1)		2.5 (1.1)		0.54
	<i>n</i>	%	<i>n</i>	%	
Year in school					
Freshman	36	26	29	27	0.33
Sophomore	36	26	21	19	0.05
Junior	32	23	29	27	0.70
Senior	31	23	27	25	0.60
Ethnicity					
African American	3	2	3	3	1.00
Asian and Pacific Islander	17	12	10	9	0.13
Hispanic/Latino	10	7	2	2	0.02
Middle Eastern	1	1	1	1	1.00
White	92	67	84	78	0.09
Other	12	9	5	5	0.55
Relationship status					
Single	72	54	67	63	0.67
Committed relationship	56	42	35	33	0.03
Engaged/married	3	1	2	1	0.56
Other	2	1	2	2	1.00
Parenthood status, have children (yes)	0	0	0	0	

Table II Intentions of having children.

	Women		Men		Gender difference (P)
	n	%	n	%	
Want to have children					
Yes	116	88	95	91	0.74
Desired number of children					0.07
1	1	1	1	1	
2	48	41	49	54	
2–3	6	5	9	10	
3	35	30	21	23	
4 or more	26	22	10	11	
Desired age at first child (years)					0.46
21–24	4	4	1	1	
25–29	82	75	49	56	
30–34	21	19	32	37	
35–39	2	2	5	6	
Desired age at last child (years)					0.94
25–29	9	8	1	1	
30–34	59	53	40	45	
35–39	35	31	39	44	
40–44	8	7	6	7	
45–50	1	1	2	2	

Intentions of having children

When indicating on a 0–10 point scale, how important it was to have a child, both men and women rated this as highly important (mean = 8.3, SD = 2.5; mean = 8.5, SD = 2.9, respectively). Table II presents participants' future intentions regarding children, their desired number of children and expected age at which they planned to have children. Eighty-nine percent of participants indicated they want to have children in the future. Three-quarters of women and 87% of men wanted two or three children. Twenty-two percent of women and 11% of men wanted four or more children. Women and men wanted to have their first child in their late twenties: 27.4 years (SD = 4.5) for women and 27.9 (SD = 5.8) for men. Seventy-five percent of women wanted to have their first child between the ages of 25 and 29 compared with 56% of men. Only 19% of women desired to have their first child between the ages of 30 and 34, compared with 37% of men. Both women and men wanted to have their last child at the age of 33.4 (SD = 3.6, women; SD = 7.0, men). Both men and women reported being 'somewhat confident' that they would have their desired number of children at their desired ages [mean: 3.1 (SD = .85) women versus 3.3 (SD = .78) men].

Perceived knowledge of fertility issues

The average participant reported their knowledge of fertility issues as slightly greater than 'somewhat educated'. Approximately half of participants believed they were either 'educated' or 'very educated' regarding fertility issues. Women and men reported gaining most of their fertility knowledge from school (46%), family (20%), media

(15%), friends (9%) and doctor/gynecologists (5%). Women were more likely to report gaining their fertility knowledge from their family and doctor/gynecologists ($\chi^2(1) = 6.8$, $P = .009$) and ($\chi^2(1) = 6.2$, $P = 0.01$, respectively).

Perceived obstacles to having the number of children they desire

Participants were asked to indicate potential obstacles they perceived might prevent them from having the number of children that they wanted at the ages at which they planned. Participants' responses included pursuit of career aspirations (76%), not finding the correct partner (54%), financial concerns (52%), pursuit of personal interest (42%), educational pursuits (34%), not feeling emotionally ready (33%) and infertility (25%). Men and women had similar perceptions of these obstacles with the exception of infertility with 32% of women viewing this as a potential obstacle compared with only 16% of men ($\chi^2 = 8.5$, $P = 0.004$).

Intended behavior in the event of infertility

Table III presents women and men's intended behavior in the event of infertility. Women and men were likely to pursue IVF treatment (see Table III). Men and women were also likely to choose to pursue adoption with women more likely than men ($Z = -3.73$, $P = 0.0002$). Women and men reported being unlikely to choose to live a childfree lifestyle.

Awareness of fertility issues

Participants were asked a series of open response questions regarding their awareness of fertility issues. Thirty-two percent of women and

36% of men overestimated the age at which women were the most fertile. Women and men vastly overestimated the age at which women experience a *slight* decline in their fertility (83% of women

and 91% of men). Men and women also overestimated the age at which women experience a *marked* decrease in fertility (67% of women and 81% of men), with men estimating the age to be significantly higher than women ($t(194) = -3.2, P = 0.01$). Ninety-two percent of women and 82% of men overestimated the likelihood of pregnancy between couples following unprotected intercourse at the time of ovulation, with women estimating a higher percentage chance of pregnancy compared with men ($t(189) = 2.7, P = 0.01$). The same pattern held true when estimating the likelihood of pregnancy after 1 year of unprotected intercourse ($t(228) = -2.8, P = 0.01$). Over half of women and men overestimated the percentage of couples in the USA experiencing involuntary childlessness. Finally, both men and women overestimated the chances that couples who undergo IVF would have a child following one treatment with 52% of women and 64% of men overestimating the correct range ($t(226) = -2.6, P = 0.01$; Table IV).

Table III Presumed behavior in case of infertility.

	Women (n = 129–130), mean ^a (SD)	Men (n = 103–104), mean (SD)	t
Undergo IVF	6.0 (3.3)	6.4 (2.9)	-0.92
Adoption	7.9 (2.8)	6.6 (2.7)	3.5*
Choose not to have children	3.7 (3.2)	3.9 (2.3)	-0.31

^aMeans are based on a 0–10 point scale.
*P < 0.001.

Table IV Women and men's awareness of fertility issues.

Items	Categories	Women (n = 118–126) (%)	Men (n = 95–104) (%)	P
At what age are women most fertile?	15–19	25	26	0.24
	20–24 ^a	44	38	
	25–29	29	27	
	30–44	3	9	
At what age is there a <i>slight</i> decrease in women's ability to become pregnant?	15–24	0	1	0.09
	25–29 ^a	18	8	
	30–34	37	31	
	35–59	46	60	
At what age is there a <i>marked</i> decrease in women's ability to become pregnant?	25–34	9	5	0.002
	35–39 ^a	24	14	
	40–44	36	29	
	45–60	31	52	
A young woman (<25 years) and a man have unprotected intercourse at the time of ovulation—how large is the chance that she will then become pregnant?	0–29%	6	15	0.01
	30–39% ^a	2	3	
	40–49%	6	2	
	50–100%	86	80	
A woman and a man who regularly have unprotected intercourse during a period of 1 year How large is the chance that she will become pregnant if she is 25–30 years old?	0–69%	25	14	0.31
	70–79% ^a	16	14	
	80–89%	29	29	
	90–100%	30	43	
How large is the chance that she will become pregnant if she is 35–40 years old?	0–49%	38	27	0.01
	50–59% ^a	19	14	
	60–69%	18	15	
	70–100%	25	43	
How many couples in the USA are involuntarily childless?	0–4%	2	1	0.85
	5–9%	9	16	
	10–19% ^a	32	33	
	20–90%	57	51	
Couples that undergo treatment with IVF—what is their chance, on average, of getting a child?	0–19%	21	10	0.01
	20–29%	16	17	
	30–39% ^a	11	10	
	40–100%	52	64	

^aThe category that contains the correct answer according to the published data.

Discussion

Undergraduate university students in this study highly valued parenthood and nearly 90% planned to become parents. However, they demonstrated a significant lack of awareness regarding fertility issues—a finding consistent with studies conducted with university students in Sweden, Finland, Canada, Italy and Israel (Lampic et al., 2006; Bretherick et al., 2010; Rovei et al., 2010; Hashiloni-Dolev et al., 2011; Virtala et al., 2011). Even though participants generally perceived themselves as being educated about fertility issues, both men and women vastly overestimated the ages at which female fertility shows a slight and a marked decline. The discrepancy between their perceived knowledge and what is known regarding the science of reproduction is alarming and could lead to involuntary childlessness if men and women's reproductive decisions are based on inaccurate perceptions.

Contrary to societal trends in the USA that demonstrate an increase in age for first-time mothers (Heck et al., 1997; Martin et al., 2009; Mathews and Hamilton, 2009), only 2% of female participants planned to have their first child at age 35 or older. This apparent discrepancy between childbearing intentions and actual trends may shed light on the complex decision-making process that occurs when women must balance childbearing with education, career aspirations, health and partner selection (Benzies et al., 2006; Cooke et al., in press; Mills et al., 2011). Should a young woman's educational and career goals become of greater importance as she ages, she may postpone motherhood to accommodate these other priorities, whether this postponement is consistent with her original plans or not. This may be particularly true for educated women, (Virtala et al., 2006) and for women who incorrectly overestimate their fertility (Lampic et al., 2006; Skoog Svanberg et al., 2006). Furthermore, both women and men placed high importance upon having a partner with whom they could share the responsibility of parenthood, a finding consistent with a growing body of research indicating that relationship status plays a significant role in the decision to begin or postpone childbearing (Benzies et al., 2006; Tough et al., 2007). In fact, the struggle to find a partner can lead to the postponement of childbearing for much longer than a woman intends (Cooke et al., in press). Studies also find that individuals who do have a partner consider his or her desires when making childbearing decisions (Tough et al., 2007). Therefore, a woman whose partner wishes to postpone having children may do so, in spite of her own plans and intentions. Future longitudinal studies which examine women's childbearing intentions and actual reproductive choices would be valuable to enhance our understanding of this issue.

When indicating where they received their education regarding fertility issues, only 5% of participants reported having received fertility education from a doctor or gynecologist. This is likely because the average participant was 20 years old—an age at which students are more likely to be thinking about pregnancy prevention rather than family planning. We agree with the recommendation from Tyden et al. (2006) that gynecologists and doctors should not only provide young patients with information regarding contraception, but also inform patients about the relationship between fertility and age, even though they may not yet be at an age when they are planning to have children. Female university students are a group that is likely to delay childbearing and this study, coupled with other recent studies (Quach and Librach, 2008; Bretherick et al., 2010) support

the need for education on fertility and aging. If future decisions to postpone childbearing are based on misconceptions about fertility and aging, many women, especially those who are educated and career oriented may unknowingly experience infertility and may ultimately experience involuntary childlessness.

While most participants wanted to have at least two children at ages within a woman's window of fertility, over half of men and nearly 40% of women wanted to have their last child between the ages of 35–44. These plans are concerning not only due to the rapid decline in female fertility at this age (Menken et al., 1986), but because participants lacked accurate knowledge about fertility rates at this age. Two-thirds of women and 81% of men inaccurately believed that female fertility markedly declines after the age of 40, with one-third of women and nearly half of men believing this decline takes place after the age of 44—an age at which there is only a 3.2% success rate per cycle of IVF (Center for Disease Control and Prevention, 2008).

In the event of future infertility, women and men were likely to pursue IVF treatments. However, they greatly overestimated the likelihood of IVF treatment success—an inaccurate perception that has been found in other international surveys (Adashi et al., 2000; Lampic et al., 2006; Maheshwari et al., 2008). Infertility specialists are consistently surprised by the number of highly educated older couples who have unrealistic expectations of fertility treatments (Van Voorhis, 2007). A recent review examining the demographic and medical consequences of delayed childbearing indicated that despite widespread availability of high-quality ARTs, they cannot overcome the age-related decline in fertility (Schmidt et al., 2012). Educating women and men regarding the effects of age on fertility, as well as the effectiveness of fertility treatments, cannot be overemphasized and is called for in virtually every study examining fertility awareness (Lampic et al., 2006; Tough et al., 2007; Maheshwari et al., 2008; Bretherick et al., 2010; Virtala et al., 2011). It is reasonable to speculate that with more accurate knowledge regarding fertility issues, women and men's intentions for childbearing may change to allow for a greater window of opportunity to fulfill desires regarding their future family composition, as the certainty of fertility intentions is a more important predictor of fertility behavior than the expected timing of future births (Schoen et al., 1999).

Among potential obstacles that would prevent study participants from having the desired number of children at the age they desired, career aspirations was the most frequently reported (76% of participants), while infertility was the least mentioned obstacle (25%). A recent review on postponement of parenthood illuminates the difficulties of combining career aspirations with motherhood (Mills et al., 2011). Balancing parenting and occupational roles is extremely difficult considering that these roles are each characterized by an intense demand for time. Economists also argue that there is a 'wage penalty' for mothers within the work force who bear children early, meaning women who postpone motherhood will likely earn substantially higher pay than those who do not (Mills et al., 2011). This monetary incentive to wait, accompanied by economic uncertainty may be related to the postponement of parenthood, particularly since studies demonstrate a desire to be financially stable prior to having children (Tough et al., 2007), and an expectation, for women, that parenthood would lead to 'fewer job opportunities' (Lampic et al., 2006). With regard to infertility, women in the present study were more likely

than men to view it as a potential obstacle (32 women versus 16% men), and the study findings seem to indicate that they have a reasonable amount of anxiety about their plans for parenthood, despite their lack of awareness regarding the magnitude of the problem they face.

There is a critical distinction between women who consciously decide against parenthood and those who unknowingly postpone parenthood and end up experiencing infertility (Kemkes-Grottenthaler, 2003). A survey of 127 childless female academics suggested that only 14% of women had made the decision to forgo children, while 71% of participants postponed childbearing due to other issues, particularly issues that were job related (Kemkes-Grottenthaler, 2003). In a recent qualitative study, Cooke *et al.* (in press) concluded that women rarely make a conscious choice to delay childbearing, and rather feel that the timing of childbearing, influenced by external factors such as finding the right partner, is commonly beyond their control. Another study also characterized women as informed and uninformed decision-makers with regard to their fertility choices, with women in the uninformed group stating they would have attempted childbearing sooner had they been more aware of the risks of advanced maternal age (Cooke *et al.*, 2010). The findings of the present study demonstrate a need for education regarding infertility, particularly as it relates to advanced maternal age, which complements the desire for this type of education demonstrated by participants in the Cooke study.

Findings from this study should be interpreted in the context of its limitations. The response rate of 31% is lower than typical response rates associated with postal surveys, and the use of an online survey likely reduced this overall rate. The low response rate may be partially explained because the researchers were prohibited from contacting the students more than twice, and increased contact is associated with increased response (Cook *et al.*, 2000). However, the response rate of the present study is consistent with the average response rate of 39.6% reported in a meta-analysis of 68 online surveys (Cook *et al.*, 2000). An analysis of non-respondents did not indicate selection bias with regard to age and number of years of education, but male respondents were more likely to be White compared with male non-respondents, and there were fewer Hispanic/Latino and more White students in the sample than would be predicted by the proportion of these ethnicities in the overall student body. It may also be likely that students who had greater interest in fertility issues were more likely to respond to the study invitation. Future studies that obtain a higher response rate and include more minority and underrepresented voices would be a valuable complement to the current study. In addition, future studies which assess the fertility awareness of American graduate students would significantly add to this research, as these students are even more at risk for involuntary childlessness, given their advanced age and career aspirations (Skoog Svanberg *et al.*, 2006).

In conclusion, participants in this study significantly overestimated nearly every aspect of female fertility including the ages at which fertility declines and the success rate of IVF treatments. Although men and women plan to have their first and last child within a woman's window of fertility, the vast overestimation of female fertility could lead to delayed childbearing and involuntary childlessness due to age-related fertility decline. Increased efforts to improve education of fertility issues in the USA is needed to address the significant lack of awareness regarding fertility in college-aged men and women.

Authors' roles

B.D.P. designed the study, collected the sample, wrote the initial draft of the manuscript and participated in all phases of the study. M.P. conducted data analysis and participated in study design. L.T. conducted the literature review and participated in data analysis and manuscript construction. C.L. was the leader of the Swedish study on which this study is based (see *Human Reproduction*, 2006), and she participated in instrumentation design, study implementation, data analysis and manuscript preparation. All authors contributed to the subsequent revisions to the text.

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Conflict of interest

None declared.

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