Research Article

Does a Career in Orthopaedic Surgery Affect a Woman's Fertility?

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ABSTRACT

Background: Orthopaedic surgery lags behind other specialties in the recruitment of women. Concerns about fertility, pregnancy, and childbearing may be a deterrent to women when considering orthopaedic surgery as a specialty.

Methods: An anonymous 168-item survey was distributed to the members of Ruth Jackson Orthopedic Society and the Women in Orthopaedics, an online group exclusive to female orthopaedic surgeons. Respondents were queried regarding family planning, contraceptive length of use, fertility, perinatal work habits, age and stage at each pregnancy, pregnancy complications, and miscarriages.

Results: Eight hundred one surveys were collected. Seven hundred fifty (94%) expressed interest in having children of their own, with 60% having at least one child at the time of the survey. The average maternal age at birth of the first child was 33.6 ± 3.6 years. Voluntary childlessness was reported by 6% (49/801) of survey respondents. Eighteen percent of this group stated that their choice as an orthopaedic surgeon served as a barrier to having children. Among those with children, childbearing was intentionally delayed by 53% because of their career choice (425/801). Fifty-two percent did not conceive their first child until the end of their training. Complications during pregnancy were reported among 24%. A total of 853 children were conceived by this cohort with assisted reproductive technology being used 106 times. Miscarriages were reported by 38% (304/801). Of those who miscarried, only 28% informed their employer and 8% took time off during or immediately after their miscarriage.

Conclusion: Most respondents desire to have children but two-thirds delay doing so because of their career choice and its demands. Having a family is an important part of life for many orthopaedic surgeons, and our study provides an updated description of the fertility and pregnancy characteristics of female orthopaedic surgeons to help guide present and future surgeons in their family planning.

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Dr. Poon or an immediate family member reports grants from the Pediatric Orthopaedic Society of North America (POSNA) and personal fees from Medtronic Inc. and Stryker Inc. outside of the submitted work. None of the following authors or any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this article: Ms. Luong, Dr. Hargett, Dr. Lorimer, Dr. Nguyen, Dr. Payares, and Dr. Friedman.

The views expressed in this manuscript reflect the results of research conducted by the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the United States Government.

J Am Acad Orthop Surg 2021;29:e243-e250

DOI: 10.5435/JAAOS-D-20-00198

With the slow but steady increase in the number of women choosing a career in orthopaedic surgery,[1,2] questions regarding pregnancy, infertility, and risk of miscarriages are becoming increasingly important for the orthopaedic community. Although it is likely that many professional women choose to delay childbearing, the length of surgical training and the demands of the career itself often compel women surgeons to delay pregnancy and childbirth.[3-5] Because fertility rates decrease after the age of 30 and maternal age greater than 35 are associated with increased risk of maternal and fetal complications,[6-10] the delay in childbearing for the female surgeon may have a notable impact on the surgeon's personal and reproductive life. The infertility rate is reportedly higher in female orthopaedic surgeons than the general US cohort. Compared to other surgical subspecialties, orthopaedic surgery is in the top three fields at highest risk for female infertility as well as pregnancy complications.[3,4]

The training and career of a female orthopaedic surgeon involves long working hours, unpredictable schedules, and call responsibilities that involve working late into the night, which can present additional challenges to pregnancy and parenthood.[4] In addition, orthopaedic surgeons have physically demanding careers that often require heavy lifting and standing for many hours at a time. Prolonged standing, high work fatigue score, and nighttime work have been reported to be markedly associated with preeclampsia and preterm birth.[11,12] The purpose of this study is to provide an updated description of reproductive behavior, fertility rate, use of infertility services, pregnancy complications, and perinatal work patterns in a large cohort of female orthopaedic surgeons.

Methods

An anonymous 168-item survey was created by the authors with the input of a maternal fetal medicine subspecialist and distributed through SurveyMonkey (SurveyMonkey). Respondents were asked to answer questions regarding multiple topics, including family planning, length of contraceptive use, fertility, perinatal work habits, age and career stage at each pregnancy, pregnancy complications, and information regarding miscarriages. Fertility indicators included having biological children, maternal age at first birth, and need for fertility treatment. Respondents were also queried as to whether they delayed having children because of their career choice. Demographic information was collected and included the following: orthopaedic subsubspecialty, years of practice, and relationship status. Skip Logic was used throughout the survey to enable the customization of the survey questions based on the respondent's answer to a previous question.

The survey was distributed to the members of the Ruth Jackson Orthopedic Society (n = 800) and to the members of Women in Orthopaedics (n = 722), an online group exclusive to female orthopaedic surgeons in practice or in training. The recruitment period was from April 2018 to August 2018. Access to the survey was granted through an online link that allowed respondents one unique opportunity for completion; the multiple responses option was disabled. As a precaution, each respondent's identification number, internet protocol address, and responses were all cross-checked to further ensure that respondents were not able to complete the survey more than once. Participation and completion of the survey were done on a voluntary basis. Responses to all questions were optional, and therefore, the response rates varied for each question. Percentages and proportions are included to better explain the distributions in such cases.

Statistical analysis was performed using Stata 15 (StataCorp). The assumption of normality was assessed using the Shapiro-Wilk test and through graphical assessment. Multiple logistic regression was used to analyze the relationship between the number of children per surgeon and demographic factors (ie, age, specialty, length of delay, and average hours worked weekly). A significance level of 0.05 was adopted throughout the study.

Results

Demographics

A total of 801 surveys were completed. Most respondents, 585 of 801 (73%), were surgeons in practice. The average current age of the respondents was 38.9 ± 8.3 years. Baseline characteristics pertaining to the distribution of subspecialty, career stage, and marital status are outlined in Table 1.

Voluntary childlessness was reported by 6% (49/801) of respondents, with 18% (9/49) selecting "My job as an orthopedic surgeon interferes with having children" as the reason. An overwhelming majority of respondents, 94% (750/801), stated that they were interested in having children of their own, with 60% (452) stating that they had at least one child at the time the survey was distributed.

Table 1. **Baseline Characteristics of Study Participants**

Characteristics	
Mean age (yr) at the time of survey[a]	
Overall	38.9 ± 8.3
With children	41.9 ± 17.3
Specialty of respondents[b]	n
Arthroplasty	53
Foot and ankle	54
General	75
Hand	149
Oncology	26
Pediatrics	152
Shoulder and elbow	21
Spine	18
Sport	109
Trauma	64
Other	75
Life stage (at time of survey)	
Intern	16
Resident	101
Fellow	61
Attending	517
Have kids[c]	
Yes	452
No	298
Want kids[d]	
Yes	750
No	49
Delayed having children[e]	
Did not delay	148
6 mo to 1 yr	21
1-2 yr	68
3-4 yr	71
4-5 yr	48
>5 yr	96

[a]Mean age was calculated from a total of n = 798 respondents who denoted their age at the time of the survey.
[b]In total, n = 796 answered demographic questions regarding their specialty and n = 695 life stage.
[c]n-750 answered the questions regarding if they currently have kids.
[d]Two respondents did not answer the questions regarding wanting children.
[e]Among those who have children, n = 452 answered the question regarding how long they delayed.
Total amount of surveys completed was N = 801.

Of the surgeons who had children, over half (52%) did not have their first child until they were done with training, with 36% having their first child during residency and 12% during fellowship. Childbearing was intentionally delayed by 67% of the respondents because of their career choice as an orthopaedic surgeon (304/452). Among those who stated that they chose to delay conception, 48% delayed more than 3 years and 23% delayed for more than 5 years (Table 1). Of those who did not currently have children but expressed the desire for childbearing, 69% (206 of 298) were delaying their pregnancy.

Fertility Characteristics: Natural Conception Versus Assisted Reproductive Technology

Natural conception was reported by 82% (359/437) of respondents with children. Infertility services were sought by 17% (74/437) of surgeons for their first child. Data pertaining to the mode of conception was obtained for 847 individual pregnancies. The average maternal age at birth of the first child was 33.6 ± 3.6 years (n = 452), 35.7 ± 2.9 years (n = 252) for the second, and 37.1 ± 3.2 years (n = 57) for the third.

Natural conception was reported for 742 of 847 pregnancies (88%), with infertility services used for 105. There were 38 instances of reported fertility abnormalities found during fertility testing. Table 2 details the different fertility abnormalities reported by respondents. Fifty-eight respondents reported issues that hindered their ability to conceive. Of these, 31(53%) stated they could not conceive because of either advanced maternal age, health-related issues (diagnosed later in life), and/or multiple failures using assisted reproductive technology (ART).

Birth control use before having children (P = 0.443), birth control type (P = 0.830), age while trying to conceive (P = 0.140), hours spent standing while operating (P = 0.334), and professional stage at birth (P = 0.797) were not found to be associated with the increased risk for requiring ART.

Pregnancy Complications

Pregnancy complications were reported among 207 of 847 pregnancies (24%). For natural conception, the pregnancy complication rate was 27% (174/642) and for those using ART, it was 31% (33/106) (P = 0.390). Multiple respondents reported experiencing more than one complication. Table 3 describes the most common complications of pregnancy experienced among respondents.

Having a multigestational pregnancy was found to be a risk factor ($P < 0.001$) for experiencing a pregnancy

Table 2. Reported Fertility Abnormalities Across Three Pregnancies

Fertility Abnormality	First Pregnancy (n = 452)	Second Pregnancy (n = 257)	Third Pregnancy (n = 60)
Abnormal hormone levels	7 (1.5)	1 (0.4)	0
Anovulation	6 (1.3)	1 (0.4)	0
Advanced maternal age	11 (2.4)	4 (1.6)	1 (1.7)
Polycystic ovarian syndrome	5 (1.1)	2 (0.8)	0
Male factor	0	1 (0.4)	0
Low sperm count	5 (1.1)	2 (0.8)	0
Endometriosis	0	0	0
Recurrent miscarriages	2 (0.4)	0	0
Uterine abnormalities	3 (0.7)	0	0
Tubal factor	2 (0.4)	1 (0.4)	0
Hyperprolactinemia	0	0	0
Unexplained/unknown	51 (11.3)	17 (6.6)	0
Other	1 (0.2)	1 (0.4)	0
More than one fertility abnormality reported	13 (2.9)	2 (0.8)	1 (1.7)
At least one fertility abnormality reported	76 (16.8)	29 (11.3)	2 (3.3)
No complication	376 (83.2)	228 (88.7)	58 (96.7)

Multiple respondents reported multiple abnormalities during testing.

complication. Age at conception (P = 0.572), hours per week operated (P = 0.953), professional stage at the time of conception (P = 0.840), and mode of conception (P = 0.304) were not associated with increased risk of pregnancy complication.

During the first pregnancy, expectant mothers on average took call until 37 ± 4 weeks of gestation, operated until 36 ± 5 weeks, and worked in the clinic until 38 ± 4 weeks of gestation. Of the children born to this cohort, 10% (83/853) required admittance to the neonatal intensive care unit (NICU) on delivery.

Delivery Complications and Medical Complications After Birth

Delivery complications were reported in 197 of 769 (26%) pregnancies. Risk of experiencing a delivery complication was increased among those who had a multigestational pregnancy ($P < 0.001$). Maternal age at birth (P = 0.44), hours spent operating (P = 0.347), and professional stage at the time of birth (P = 0.897) were found to not increase the risk of a delivery complication. After delivery, 83 of 817 (10%) children required admission to the NICU. Eighteen children required a hospital stay that extended beyond the mother's planned maternity leave. Overall average NICU stay was 13.57 days (range 1 to 90). The average maternal age among those with children needing NICU stay was 34.6 ± 3.0.

A total of 55 (6.7%) children had a diagnosed disorder at birth, with 39 of them requiring additional hospital, physical therapy, occupational therapy visits, or other medical care. Only pregnancy complication ($P < 0.001$) was found to be a significant risk factor for offspring medical complication. Maternal age at delivery (P = 0.376), professional stage (P = 0.670), hours worked (P = 0.179), multiparity (P = 0.531), and the use of ART (P = 0.440) did not increase the risk of medical complication for the child.

Miscarriages

Miscarriages were reported among 33% (160/486) of survey respondents who attempted to conceive. Among those who successfully had children, 34% (154/452) reported experiencing a miscarriage while trying to conceive. Among those who reported having had a miscarriage, 153 respondents provided information regarding their management of the miscarriage. Most 95% (146/153), resumed work immediately after miscarrying. Only 8% (12/153) sought counseling regarding their miscarriage, and 28% (43/153) informed their work regarding their miscarriage.

Table 3. Pregnancy Complications

Complications	First Pregnancy (n = 452)	Second Pregnancy (n = 257)	Third Pregnancy (n = 60)
Gestational diabetes	18 (4.0)	8 (3.1)	2 (3.3)
Preeclampsia	29 (6.4)	10 (3.9)	0
Intrauterine growth restrictions	4 (0.8)	3 (1.2)	1 (1.7)
Oligohydramnios	11 (2.4)	6 (2.3)	0
Polyhydramnios	1 (0.2)	0	1 (1.7)
Eclampsia	1 (0.2)	1 (0.4)	0
Preterm labor with preterm delivery	20 (4.4)	10 (3.9)	3 (5.0)
Preterm labor with term delivery	11 (2.4)	10 (3.9)	3 (5.0)
Cervical insufficiency	13 (2.9)	4 (1.6)	2 (3.3)
Premature rupture of membranes	8 (1.8)	3 (1.2)	1 (1.7)
Placental abruption	2 (0.4)	1 (0.4)	0
Placenta previa	7 (1.5)	3 (1.2)	0
Bleeding of unknown source	4 (0.8)	1 (0.4)	1 (1.7)
Placenta accreta or other placental problems	2 (0.4)	1 (0.4)	0
Chorioamniotis	1 (0.2)	0	0
Other	23 (5.1)	24 (9.3)	3 (5.0)
No complications	334 (73.9)	192 (74.7)	46 (76.7)
More than one complication	32 (7.1)	18 (7.0)	6 (10.0)
At least one complication	118 (26.1)	65 (25.3)	14 (23.3)

Multiple Gestation Pregnancies

Forty-six pregnancies were defined as being multigestational, with 94 children being born. Of these 46 pregnancies, 20 were conceived naturally and 26 via ART. Both age at conception ($P = 0.046$) and mode of conception ($P < 0.001$) were found to significantly increase the risk for multigestational pregnancy.

Discussion

It has been previously shown that women who choose to pursue demanding careers such as orthopaedic surgery have children later in life when compared with the general cohort.[3,5] In this cohort of female orthopaedic surgeons, childbearing was intentionally delayed by 57% of the respondents because of their career choice, with 48% delaying more than 3 years and 23% delaying more than 5 years. The lack of control over schedules during training, unpredictable call schedules, threats to career, or conflict with colleagues caused by pregnancy are all potential reasons for delay that have been cited in the literature.[5,13,14] Regardless of the reason for delaying childbearing, greater maternal age increases the risk of infertility and perinatal complications.[10,11,15-18] The average maternal age of first pregnancy in this group was 33.6 ± 3.6 years, which is consistent with previous reports of average maternal age among women surgeons.[3,4]

The reported infertility rate of 17% in our cohort is higher than the national average of 9.1% among nulliparous women between 30 to 34 years old in the United States[6] but lower than the "1/3 of the women having their first child after age 35" reported by the Office of Women's Health in the U.S. Department of Health and Human Services.[19,20] Compared with previously reported rates of 20.5% and 30% among female surgeons and female orthopaedic surgeons, respectively, our larger cohort had a lower reported infertility rate.[3,4]

Female orthopaedic surgeons have several infertility risk factors including advanced age,[8,9,21,22] pursuit of higher education,[23] and increased income.[23,24] In addition, female orthopaedic surgeons spend more time in the operating room and are more likely to work more than 60 hours per week compared with other surgical specialties.[25] Certain common conditions of orthopaedic training and practice including long work hours,[26] physical and psychological stress,[27,28] working late at

night, physical labor involving standing for many hours at a time, and lifting heavy loads[29] are known factors that affect pregnancy rates. These are all factors that may contribute to female orthopaedic surgeons having a higher rate of infertility compared with the general cohort. The reason for the lower infertility rate compared with previous reports is unclear. It is unlikely that there were any notable changes during the 5 to 7 years between the previously published reports regarding the infertility rate of female surgeons and today. We surmise that our lower rate may simply be secondary to a larger sample size. In addition, we did not find any association between birth control type or use, age while trying to conceive, hours spent standing operating, subspecialty or career stage, and increased need for ART to conceive. This updated information is intended to provide current and future female orthopaedic surgeons in their reproductive years additional data to aide in their family planning decisions.

Orthopaedic surgeons experienced a higher rate of pregnancy complications compared with the US national rate (24% versus 13 to 17%)[30,31] and also compared with age-adjusted rates of complications for women between 35 and 39 years old (20.6%).[32] Katz et al[33] showed an increased risk of adverse late pregnancy events for practicing physicians secondary to long work hours, physical, and physiological stress. Takeuchi et al also reported that long working hours for physicians were associated with pregnancy complications,[34] and a meta-analysis by Cai et al[35] showed pregnant women who work rotating shifts, fixed night shifts, or longer hours have an increased risk of adverse pregnancy outcomes. Orthopaedic residents work a mean of 70.2 hours per week, whereas attending surgeons worked a mean of 62.8 hours per week.[36] A greater percentage of female orthopaedic surgeons reported working more than 60 hours per week while pregnant and spending more time in the operating room than surgeons in nonorthopaedic specialties.[4] In our study, expectant orthopaedic surgeons took call and operated until 37 weeks of gestation and continued to see patients in the clinic until 38 weeks. It is unclear if the pregnancy complications seen in this cohort are related to advanced maternal age or related to job-related stressors in orthopaedic surgery. However, our reported pregnancy complication rate is lower than the previously reported rates of 31.2% for female orthopaedic surgeons and 35.3% for other female surgical subspecialists.[4] Although others have found increased risk of preterm labor and delivery in surgeons working more than 60 hours per week during pregnancy,[4] our results show no evidence that maternal age at conception, hours per week operated, professional stage at time of conception, or mode of conception is associated with increased risk for pregnancy complication. Having a multigestational pregnancy was the only risk factor found to be associated with increased pregnancy complication.

After delivery, 83 children were admitted to the NICU. Eighteen children required a hospital stay that extended beyond the mother's planned maternity leave. 6.7% of the children had a diagnosed disorder at birth. Birth defects occur in approximately 3% of all live births in the United States.[37] Our cohort had a higher rate of congenital anomalies than the general cohort but similar to the reported 6.8% and 8.9% of congenital anomalies for female orthopaedic surgeons and nonorthopaedic surgeons, respectively.[4] National data about birth defects show that advanced maternal age tends not to effect neonatal outcome other than an increase in chromosomal anomalies.[38] In our study, pregnancy complication was found to be the only notable risk factor for offspring medical complication. Although orthopaedic surgeons are exposed to a unique set of occupational hazards such as ionizing radiation compared with other surgical subspecialties, published literature indicates no evidence of increased fetal abnormalities compared with other surgical subspecialties.[4,39] Our results supports these findings. This cohort also reported 20 (5%) natural multigestational pregnancies, similar to the national average of 3.5%.

In the cohort studied, 33% reported having had a miscarriage. Early miscarriage is an unexpected pregnancy complication that affects up to 25% of pregnant women.[40,41] In a study on the effect of maternal age and fetal loss, the risk of fetal loss was 15.0% for women aged 30 to 34, 24.6% for women aged 35 to 39, and increased to 51% for mothers aged 40 to 44.[42] Despite adjusting for age, our cohort had a higher miscarriage rate than the general cohort. Other independent risk factors may include infertility and stress,[43,44] which are common characteristics of our study group. One potential reason for the higher rate may be that surgeons are medical professionals who are more likely to recognize the symptoms and signs of miscarriage leading to a higher reported rate. Regardless, almost all of our respondents continued to work during and immediately after a miscarriage and a majority did not inform their workplace or seek psychological treatment regarding this potentially emotionally devastating event. Up to 38% of women experience posttraumatic stress disorder symptoms after early pregnancy loss.[45] Societal norms

such as not disclosing pregnancy until after 12 weeks may reinforce the silence surrounding the grief and psychological impact of miscarriage.[45]

A limitation of this study is that the questionnaire is not a validated survey. However, the questionnaire was designed to inquire about the fertility and pregnancy experiences of female orthopaedic surgeons and the questions asked for quantitative answers. The survey itself is subject to voluntary response bias. However, 801 responses represent the largest study group of female orthopaedic surgeons to date. There were 1,016 active female orthopaedic surgeons in 2017 and 586 female orthopaedic residents in the US as reported by the Association of American Medical Colleges.[46,47] Although the data for the number of female orthopaedic surgeons in 2018 are not available, we infer that our 801 respondents represent a notable portion of those in the United States. It is also still unclear if fertility and pregnancy complications are because of the advanced maternal age of many of the respondents or if a career in orthopaedic surgery has an independent effect.

Conclusion

Over two-thirds of female orthopaedic surgeons intentionally delay childbearing secondary to their career and therefore have children at an older age than the general cohort. Although previously reported rates of infertility and pregnancy complications in orthopaedic surgeons were higher than the age-matched general US population, this cohort showed a lower rate than those previously reported for this population; this is likely secondary to a larger cohort of subjects. The updated information may be helpful to women orthopaedic surgeons who are currently trying to plan timing for childbearing. In addition, we found no association between career stage, hours worked, or subspecialty with decreased fertility or increased risk of pregnancy complication. This study included the largest number of female orthopaedic surgeons surveyed about fertility and childbearing. Having a family is an important part of life for many orthopaedic surgeons, and our study provides an updated description of the fertility and pregnancy characteristics of female orthopaedic surgeons to help guide present and future surgeons in their family planning.

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