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Factors Associated with Unplanned Pregnancy Among Cancer Survivors

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Abstract

Background: Approximately half of all pregnancies in the United States are unintended. However, women who are diagnosed with cancer in their reproductive years may be a unique population. This study examines the prevalence of and identifies factors associated with unplanned pregnancy among cancer survivors.

Materials and Methods: Female cancer survivors aged 22–45 years, diagnosed between ages 20–35 years and at least 2 years postdiagnosis, and women with no history of cancer were interviewed about their reproductive histories, including pregnancy intention. Using a random matching process, comparison women were assigned an artificial age at cancer diagnosis equal to that of her cancer survivor match. An adjusted Cox model was fit examining time to unintended pregnancy after cancer for each of 1,000 matches. Cox proportional hazards models were also fit to assess associations between participant characteristics and unplanned pregnancy after cancer among survivors.

Results: Cancer survivors ($n = 1,282$) and comparison women ($n = 1,073$) reported a similar likelihood of having an unplanned pregnancy in models adjusted for race, income, history of sexually-transmitted infection, and history of unplanned pregnancy before diagnosis (adjusted hazard ratio [aHR] 1.06, 95% simulation interval 0.85–1.36). After adjusting for confounders, unplanned pregnancy among survivors was associated with age <30 years at diagnosis (hazard ratio [HR]: 1.79, 95% confidence interval [CI]: 1.32–2.44), black race (HR: 1.55, 95% CI: 1.13–2.12; referent: white), receiving fertility counseling (aHR: 1.41, 95% CI: 1.04–1.92), and having at least one child before diagnosis (aHR: 1.44, 95% CI: 1.05–1.97).

Conclusion: Cancer survivors and comparison women had similar likelihood of unplanned pregnancy. Rates of unplanned pregnancy after cancer were not higher for cancer survivors compared with comparison women, but 46.4% of survivors with a postcancer pregnancy reported an unplanned pregnancy. Cancer patients may benefit from patient-centered guidelines and counseling before cancer treatment that covers both risks of infertility and risks of unplanned pregnancy.

Keywords: unplanned pregnancy, fertility counseling, cancer survivorship, contraceptive counseling, family planning

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Introduction

Approximately 92,960 women aged 44 years or younger were diagnosed with cancer in the United States in 2020.[1,2] Meanwhile, the overall 5-year cancer survival rate approaches 70%[3] leading to increasing focus on issues associated with cancer survivorship, including fertility and family planning. Nevertheless, studies suggest that many reproductive-aged cancer survivors feel that their concerns about reproduction and sexual health are inadequately addressed.[4,5]

In the United States, ~45% of pregnancies are unintended (wanted later or not at all).[6] However, little is known about reproductive-aged female cancer survivors.[7] While some cancer treatments impair fertility[8–10] or increase risk of premature ovarian failure (POF),[11–15] most reproductive-aged cancer survivors continue to menstruate after treatment.[16–18] Previous studies suggest that cancer survivors have sexual and contraceptive practices that put them at risk for unplanned pregnancy. Survivors have been reported to be thrice more likely to have regular unprotected intercourse compared with women with no history of cancer,[16] and survivors who use contraception are less likely to use the most effective forms (Tier I/II).[19,20] Female cancer survivors may also be more likely to use emergency contraception compared with the general population.[21] Generally, survivors may have inadequate awareness of their contraceptive options.[22,23]

We report the prevalence of unplanned pregnancy in a cohort of reproductive-aged female cancer survivors and identify factors associated with unplanned pregnancy after cancer.

Materials and Methods

Study population

The Furthering Understanding of Cancer, Health, and Survivorship in Adult (FUCHSIA) Women's Study is a population-based study examining the effect of cancer during the reproductive years on future fertility. Female cancer survivors were identified across the state of Georgia in collaboration with the Georgia Cancer Registry as described in greater detail elsewhere.[24] Survivors diagnosed between 1990 and 2009 with any reportable malignant cancer[25] or ductal carcinoma *in situ*, who were between the ages of 20–35 years at diagnosis, and were at least 2 years postdiagnosis were eligible. Recruitment for those diagnosed with thyroid cancer and melanoma was restricted to Metropolitan Atlanta. Comparison women with no history of cancer represented the general population. Comparison women were identified using a purchased marketing list and were frequency matched to the survivors on age and location of residence. All women were 22–45 years old at enrollment (2012–2013), had a working telephone, and spoke English.

Informed consent was obtained from all participants. The Emory University and Georgia Department of Public Health Institutional Review Boards approved this study.

Procedures

Participants were interviewed by telephone about their demographics, desire for children, reproductive history, menstrual history, medical history, and lifestyle. Cancer survivors also answered questions about their cancer history. Cancer diagnosis and treatment information were abstracted from medical records.

For each pregnancy, participants were asked their age at pregnancy and whether or not contraception was being used at the time. Pregnancies occurring when women were actively contracepting were considered unplanned pregnancies. Women who got pregnant while not using any contraception were asked whether they were trying to become pregnant with the options "trying," "neither trying nor not trying," or "not trying." Women who reported a pregnancy for which they were "not trying" were classified as having an unplanned pregnancy.

Factors hypothesized to be associated with unplanned pregnancy included age, self-identified race, education, income, health insurance status, gravidity, parity, history of ever using hormonal contraception or a nonhormonal intrauterine device (Cu-IUD), marital status, obesity, smoking history, current alcohol use, and ever diagnosed with a chronic medical condition. Cancer-related factors of interest included type, chemotherapy or radiation treatment, time since diagnosis, fertility counseling, hormone-receptor sensitivity and tamoxifen use (breast cancer survivors only), and having an abortion before diagnosis. Receipt of fertility counseling was assessed by the question, "Did you talk to a doctor or other health professional about how this cancer treatment could affect your ability to become pregnant?"

Statistical analysis

Descriptive statistics was used to examine the population, comparing cancer survivors with comparison women.

To compare rates of unplanned pregnancy after cancer, each cancer survivor was randomly matched with replacement to a comparison woman in the study population based on birth year and parity at age of cancer diagnosis. Comparison women were assigned the cancer diagnosis age of their matched pair as a proxy-diagnosis age. Cox proportional hazards models were fit to estimate time from (actual or proxy) diagnosis to first unplanned pregnancy. Participants without an unplanned pregnancy were censored at hysterectomy, bilateral oophorectomy, bilateral tubal ligation, endometrial ablation, or study interview. The matching simulation was repeated 1,000 times for each model. We report the average hazard ratio (HR) and 95% simulation interval (SI) based on the 2.5 and 97.5 percentiles of the simulation results for each model.

For cancer survivors, we examined survivor characteristics associated with unplanned pregnancy. We fit separate Cox proportional hazards models to assess the unadjusted association between each hypothesized behavioral, socioeconomic, and cancer-related factor with unplanned pregnancy. We hypothesized that the association between each factor and unplanned pregnancy would be confounded by a different set of covariates based on causal diagrams. Therefore, instead of fitting a single model, including all factors of interest, we fit separate Cox models for each factor adjusted for the relevant set of confounders.[26]

Confounders for having a precancer unplanned pregnancy and for receiving fertility counseling included age at diagnosis and race.[6,27,28] Confounders for being diagnosed with a sexually transmitted infection (STI) included race and age at

	Cancer survivors (n = 1,282)		Comparison women (n = 1,073)	
	n	%	n	%
Age at interview (years)				
22–28	53	4.1	55	5.1
29–35	340	26.5	226	21.1
36–40	489	38.1	450	41.9
40–45	400	31.2	342	31.9
Race				
White	889	69.9	712	66.8
Black	325	25.6	309	29.0
Other[a]	58	4.6	45	4.2
Level of education				
High school or less	98	7.7	52	4.9
Some college	343	26.8	257	24.0
College graduate	461	36.0	396	36.9
Some grad school or grad degree	379	29.6	367	34.2
Location of residence at interview				
Metropolitan area	127	9.9	113	10.5
Nonmetropolitan area	1,154	90.1	960	89.5
Relationship status at interview				
Married, living with a partner, or in a committed relationship	973	76.0	879	82.1
Single	292	22.8	191	17.8
Other[b]	15	1.2	1	0.1
Annual income				
Greater than $50,000	822	64.8	760	71.8
$50,000 or less	447	35.2	229	28.2
Health insurance status at interview				
Insured	1,150	89.7	961	89.6
No insurance	132	10.3	112	10.4
Had a hysterectomy or bilateral oophorectomy by interview				
Yes	322	25.1	81	7.6
No	960	74.9	992	92.5
BMI[c]				
Underweight	16	1.3	20	1.9
Normal weight	565	44.3	434	40.7
Overweight	322	25.2	308	28.9
Obese	373	29.2	305	28.6
Chronic medical condition[d]				
Yes	840	65.5	550	51.3
No	442	34.5	523	48.7
Ever had sex with a male partner				
Yes	1,248	97.4	1,040	97.0
No	33	2.6	32	3.0
Ever used contraception[e]				
Yes	1,024	79.9	910	84.8
No	258	20.1	163	15.2
Used contraception in the past 12 months[e]				
Yes	295	23.0	353	32.9
No	987	77.0	720	67.1

[a]Race category ''other'' includes: American Indian, Alaskan Native, Asian, Native Hawaiian, and Pacific Islander.
[b]Relationship category ''other'' was reserved for women who felt the other listed options did not accurately reflect their relationship status.
[c]BMI calculated using self-reported weight in pounds and self-reported height in inches. Weight was converted to kilograms (kg). Height was converted to meters (m). The formula kg/m^2 was used to calculate BMI. Underweight: BMI <18.5; Normal weight: $18.5 \le BMI < 25$; Overweight: $25 \le BMI < 30$; Obese: BMI ≥ 30.
[d]Chronic medical conditions included hypertension, congestive heart failure, cardiomyopathy, previous myocardial infarction, diabetes, depression, osteoporosis or osteopenia, eating disorders, rheumatologic conditions, and thyroid disorders.
[e]Contraception included report of use of a hormone or copper intrauterine device, oral contraceptives (combined or progesterone only), patches, vaginal ring, Depo Provera, or the subdermal implant.
BMI, body mass index.

the interview.[29–31] We did not identify any confounders for age at diagnosis, race, or location of residence (urban vs. rural).

We also performed a subanalysis restricting to breast cancer survivors, the most common diagnosis.

Results

Risk of unplanned pregnancy in cancer survivors versus comparison women

We interviewed 1,282 cancer survivors and 1,073 comparison women. Sample characteristics are shown in Table 1. A similar proportion of cancer survivors and comparison women reported ever using hormonal contraception or Cu-IUD (79.9% vs. 84.8%, respectively), but a smaller proportion of survivors reported using contraception in the past year (23.0% vs. 32.9%). Approximately half of both the cancer survivors and the comparison women reported having at least one unplanned pregnancy, and just under 5% in each group reported at least one pregnancy for which they were neither trying nor not trying (Table 2). However, 23.9% of cancer survivors were nulligravida compared to 16.2% of comparison women.

After matching on birth year and parity, cancer survivors and comparison women were equally likely to report having an unplanned pregnancy after (actual or proxy) diagnosis

TABLE 2. PREGNANCIES TO WOMEN WHO PARTICIPATED IN THE TELEPHONE INTERVIEW BY CANCER SURVIVORSHIP STATUS, 2012–2013

	Cancer survivors (n = 1,282)		Comparison women (n = 1,073)	
	n	%	N	%
Pregnancy history at interview				
Nulligravida	306	23.9	174	16.2
Gravid	976	76.1	899	83.8
Number of pregnancies by interview				
0	306	23.9	174	16.2
1	223	17.4	144	13.4
2	316	24.6	299	27.9
3	234	18.3	229	21.3
4 or more	203	15.8	227	21.2
Had at least one child by interview				
Yes	890	69.2	857	79.9
No	392	30.6	216	20.1
Had at least one unplanned pregnancy				
Yes	639	49.8	533	49.7
No	643	50.2	540	50.3
Number of unplanned pregnancies by interview				
0	643	50.2	540	50.3
1	299	23.3	245	22.8
2	162	12.6	155	14.4
3	103	8.0	65	6.1
4 or more	75	5.9	68	6.3
Reported a pregnancy that was neither planned nor unplanned				
Yes	52	4.1	52	4.8
No	1,230	95.9	1,021	95.2

(HR: 1.08, 95% SI: 0.84–1.40). The results remained null after adjusting for race, income, history of STI, and history of unplanned pregnancy before diagnosis (adjusted hazard ratio [aHR]: 1.06, 95% SI: 0.85–1.36).

Factors associated with unplanned pregnancy in cancer survivors

Among survivors in the postcancer analysis (n = 1,070), 37.3% had at least one pregnancy after diagnosis. Of the survivors with a postcancer pregnancy, 46.4% reported at least one unplanned postcancer pregnancy. Of the unplanned pregnancies after cancer, 78.4% occurred in women not using contraception at the time. Eighty-nine women reported becoming permanently amenorrheic due to cancer treatment; 3.4% of these women reported an unintended pregnancy following cancer treatment.

Factors associated with unplanned pregnancy in survivors after cancer in unadjusted models were black race (HR: 1.55, 95% confidence interval [CI]: 1.13–2.12; referent: white), being <30 years at diagnosis (HR: 1.79, 95% CI: 1.32–2.44), and receiving fertility counseling at cancer diagnosis (HR: 1.40, 95% CI: 1.03–1.90) (Table 3). Modest associations were also seen for annual income ≤$50,000, having an unplanned pregnancy before cancer diagnosis, and ever being diagnosed with an STI. Diagnosis of a hematological cancer was associated with unplanned pregnancy (HR: 1.43, 95% CI: 0.98–2.07) compared to other (referent) cancers, while breast (HR: 0.92, 95% CI: 0.65–1.32) and reproductive (HR: 1.23, 95% CI: 0.67–2.26) cancers were not associated with unplanned pregnancy.

After adjusting for confounding, having an annual income ≤$50,000 and having a history of a STI were no longer associated with unplanned pregnancy after cancer. However, other factors remained associated, including: receiving fertility counseling (aHR: 1.41, 95% CI: 1.04–1.92) and having an unplanned pregnancy before cancer diagnosis (aHR: 1.32, 95% CI: 0.96–1.81). In addition, having been pregnant at least once before cancer diagnosis (aHR: 1.33, 95% CI: 0.97–1.83) and having at least one child before diagnosis (aHR: 1.44, 95% CI: 1.05–1.97) were associated with increased risk of unplanned pregnancy after diagnosis in adjusted models.

Factors associated with unplanned pregnancy among breast cancer survivors

There were 359 breast cancer survivors who had not had a hysterectomy, bilateral oophorectomy, tubal ligation, or endometrial ablation before cancer diagnosis. Approximately 22.3% of these women reported at least one pregnancy after cancer diagnosis; among these, 61.3% reported having at least one unplanned postcancer pregnancy.

In unadjusted analyses among breast cancer survivors, there was an association between unplanned pregnancy after cancer and being <30 years at diagnosis (HR: 2.70, 95% CI: 1.53–4.76), living in a rural area (HR: 2.29, 95% CI: 1.07–4.92), and receiving fertility counseling (HR: 2.73, 95% CI: 1.16–6.41) (Supplementary Table S1). Use of adjuvant tamoxifen treatment and being hormone-receptor positive were associated with lower likelihood of unplanned pregnancy. In adjusted analyses, receiving fertility counseling (aHR: 2.70, 95% CI: 1.14–6.39) remained strongly associated with unplanned pregnancy. In addition, having hormone receptor

TABLE 3. DEMOGRAPHIC CHARACTERISTICS OF CANCER SURVIVORS BY WHETHER OR NOT THEY REPORTED AN UNPLANNED PREGNANCY AFTER CANCER DIAGNOSIS AMONG SURVIVORS WHO HAD NOT HAD A HYSTERECTOMY, BILATERAL OOPHORECTOMY, TUBAL LIGATION, OR ENDOMETRIAL ABLATION BEFORE CANCER DIAGNOSIS WITH UNADJUSTED AND ADJUSTED HAZARD RATIOS FOR FACTORS ASSOCIATED WITH UNPLANNED PREGNANCY AFTER CANCER

	At least one unplanned pregnancy after cancer diagnosis (n=185)		No unplanned pregnancies after cancer diagnosis (n=885)					
	n	%	n	%	HR	95% CI	aHR[a]	95% CI
Demographics								
Age at interview (years)					1.49	0.70–3.16		
22–28	8	4.3	41	4.6			—	—
29–35	60	32.4	243	27.5	1.64	1.12–2.40	—	–
36–40	64	34.6	331	37.4	1.23	0.85–1.78	—	–
41–45	53	28.7	270	30.5	Referent		—	—
Race								
White	113	61.8	636	72.3	Referent		—	—
Black	59	32.2	208	23.7	1.55	1.13–2.12	—	—
Other[b]	11	6.0	35	4.0	1.66	0.89–3.08	—	—
Level of education								
High school or less	14	7.6	49	5.5	Referent		Referent	
Some college	45	24.3	219	24.8	0.83	0.46–1.51	0.78	0.42–1.46
College graduate	78	42.1	327	37.0	0.89	0.50–1.57	0.93	0.51–1.67
Some grad school or grad degree	48	26.0	289	32.7	0.65	0.36–1.17	0.66	0.36–1.22
Location of residence at interview								
Metropolitan area	167	90.3	813	92.0	Referent		—	—
Nonmetropolitan area	18	9.7	71	8.0	1.40	0.86–2.28	—	—
Relationship status at interview								
Married, living with a partner, or in a committed relationship	149	80.5	668	75.7	Referent		Referent	
Single	35	18.9	205	23.2	0.78	0.54–1.12	0.77	0.53–1.11
Other[c,d]	1	0.5	10	1.1	—	—	—	—
Marital status at diagnosis								
Married	118	63.8	587	66.3	1.05	0.78–1.42	1.19	0.87–1.61
Not married	67	36.2	298	33.7	Referent		Referent	
Income								
Greater than $50,000	113	61.4	598	68.3	Referent		Referent	
$50,000 or less	71	38.6	278	31.7	1.33	0.99–1.79	1.15	0.83–1.59
Health insurance status at interview								
Insured	162	87.6	809	91.4	Referent		Referent	
No insurance	23	12.4	76	8.6	1.38	0.89–2.13	1.30	0.83–2.02
Reproductive outcomes								
Had at least one precancer pregnancy								
Yes	96	51.9	469	53.0	1.15	0.86–1.54	1.33	0.97–1.83
No	89	48.1	416	47.0	Referent		Referent	
Parity at diagnosis								
Had at least one child	82	44.3	397	44.9	1.19	0.89–1.59	1.44	1.05–1.97
Had no children	103	55.7	488	55.1	Referent		Referent	
Had an abortion before diagnosis								
Yes	19	10.3	112	12.7	0.86	0.53–1.38	0.77	0.47–1.26
No	166	89.7	773	87.3	Referent		Referent	
Had an unplanned pregnancy before diagnosis								
Yes	75	40.5	313	35.4	1.33	0.99–1.79	1.32	0.96–1.81
No	110	59.5	572	64.6	Referent		Referent	
Ever diagnosed with an STI								
Yes	66	35.7	254	28.7	1.32	0.98–1.78	1.26	0.93–1.71
No	119	64.3	631	71.3	Referent		Referent	

(*continued*)

Table 3. (Continued)

	At least one unplanned pregnancy after cancer diagnosis (n=185)		No unplanned pregnancies after cancer diagnosis (n=885)		HR	95% CI	aHR[a]	95% CI
	n	%	n	%				
Ever reported a period of infertility[e]								
Yes	78	42.6	316	37.3	1.21	0.90–1.62	1.23	0.92–1.65
No	105	57.4	531	62.7	Referent		Referent	
Ever used contraception[f]								
Yes	151	81.6	715	80.8	Referent		Referent	
No	34	18.4	170	19.2	0.98	0.68–1.43	0.93	0.63–1.38
Cancer and treatment								
Age at diagnosis								
Under 30 years	122	66.0	396	44.7	1.79	1.32–2.44	—	—
30 years or older	63	34.0	489	55.3	Referent		—	—
Time since diagnosis								
0–4 years	24	13.0	194	21.9	—	—	—	—
5–7 years	51	27.6	273	30.9	—	—	—	—
8–10 years	38	20.5	200	22.6	—	—	—	—
11+ years	72	38.9	218	24.6	—	—	—	—
Cancer diagnosis								
Breast	49	26.5	310	35.0	0.92	0.65–1.32	1.02	0.70–1.51
Hematological	42	22.7	126	14.2	1.43	0.98–2.07	1.31	0.90–1.92
Reproductive	12	6.5	69	7.8	1.23	0.67–2.26	1.22	0.65–2.29
Other	82	44.3	380	42.9	Referent		Referent	
Cancer treatment								
Surgery								
Yes	139	75.1	715	80.8	0.82	0.59–1.15	1.06	0.68–1.64
No	46	24.9	170	19.2	Referent		Referent	
Radiation								
Yes	98	53.0	416	47.0	1.19	0.89–1.59	1.22	0.90–1.65
No	87	47.0	469	53.0	Referent		Referent	
Chemotherapy								
Yes	108	58.4	507	57.3	1.13	0.84–1.51	1.08	0.74–1.58
No	77	41.6	378	42.7	Referent		Referent	
Received fertility counseling								
Yes	125	67.6	536	60.6	1.40	1.03–1.90	1.41	1.04–1.92
No	60	32.4	349	39.4	Referent		Referent	
Pursued fertility preservation[d,g]								
Yes	2	1.1	20	2.2	—	—	—	—
No	184	98.9	882	97.8	—	—	—	—
Menses after diagnosis[d,h]								
Had menses	182	98.4	799	90.3	—	—	—	—
Menses absent	3	1.6	86	9.7	—	—	—	—
Other health information								
Had a hysterectomy or bilateral oophorectomy by interview								
Yes	14	7.6	156	17.6	0.68	0.39–1.18	0.74	0.42–1.31
No	171	92.4	729	82.4	Referent		Referent	
BMI[i]								
Underweight[d]	2	1.1	13	1.5	—	—	—	—
Normal weight	90	48.7	408	46.4	Referent		—	—
Overweight	45	24.3	225	25.6	0.93	0.65–1.33	—	—
Obese	48	26.0	234	26.6	1.02	0.72–1.45	—	—
Chronic medical condition[j]								
Yes	123	66.5	565	63.8	1.14	0.84–1.54	1.15	0.84–1.56
No	62	33.5	320	36.2	Referent		Referent	

(continued)

	At least one unplanned pregnancy after cancer diagnosis (n = 185)		No unplanned pregnancies after cancer diagnosis (n = 885)					
	n	%	n	%	HR	95% CI	aHR[a]	95% CI
Ever identified as a regular smoker								
Yes	41	22.2	210	23.7	0.89	0.63–1.26	0.92	0.64–1.32
No	144	77.8	675	76.3	Referent		Referent	
Ever identified as a weekly drinker								
Yes	72	38.9	352	39.8	0.89	0.66–1.20	0.96	0.70–1.30
No	113	61.1	533	60.2	Referent		Referent	

[a]Models for age at diagnosis, age at the interview, race, location of residence, and BMI are unadjusted. Models for relationship status at the time of the interview and chronic medical condition are adjusted for age at time of interview. Model for relationship status at the time of diagnosis is adjusted for age at diagnosis. Models for income, insurance status, history of STI, ever drinker, and ever smoker are adjusted for age at interview and race. Models for level of education, having an abortion before diagnosis, receiving fertility counseling, having an unplanned pregnancy before cancer diagnosis, having at least one pregnancy before cancer, having at least one child before cancer, and cancer diagnosis are adjusted for age at diagnosis and race. Model for ever having a period of infertility is adjusted for age at diagnosis and age at the interview. Model for use of contraception is adjusted for age at interview, race, parity at cancer diagnosis, and receipt of fertility counseling. Model for receipt of cancer treatment (surgery, chemotherapy, radiation) is adjusted for cancer type. Model for hysterectomy or oophorectomy by the time of the interview is adjusted for age at interview and cancer type.

[b]Race category "other" includes: American Indian, Alaskan Native, Asian, Native Hawaiian, and Pacific Islander

[c]Relationship category "other" was reserved for women who felt that the other listed options did not accurately reflect their relationship status

[d]HRs were suppressed where cell sizes had fewer than five observations.

[e]A period of infertility was defined as a 12-month period having regular (at least three times per month) unprotected intercourse with a male partner without getting pregnant.

[f]Contraception included report of use of a hormone or copper intrauterine device, oral contraceptives (combined or progesterone only), patches, vaginal ring, Depo Provera, or the subdermal implant.

[g]Fertility preservation included those who reported having oocytes retrieved to freeze oocytes or embryos.

[h]Menstrual status assessed by participant's response to the questions, "Did your menstrual periods stop during your cancer treatment?" and "For how long did your period stop?" Women who reported their period stopping and never returning are classified as having absent menses.

[i]BMI calculated using self-reported weight in pounds and self-reported height in inches. Weight was converted to kilograms (kg). Height was converted to meters (m). The formula kg/m^2 was used to calculate BMI. Underweight: BMI <18.5; Normal weight: $18.5 \leq BMI <25$; Overweight: $25 \leq BMI <30$; Obese: BMI ≥30.

[j]Chronic medical conditions included hypertension, congestive heart failure, cardiomyopathy, previous myocardial infarction, diabetes, depression, osteoporosis or osteopenia, eating disorders, rheumatologic conditions, and thyroid disorders.

95% CI, 95% confidence interval; aHR, adjusted hazard ratio; HR, hazard ratio; STI, sexually transmitted infection.

positive cancer (aHR: 0.36, 95% CI: 0.19–0.68) and using adjuvant tamoxifen (aHR: 0.29, 95% CI: 0.11–0.74) remained associated with lower likelihood of unplanned pregnancy among survivors.

Discussion

A similar proportion of cancer survivors and cancer-free women reported unplanned pregnancies. Nevertheless, unplanned pregnancy after cancer was common (46.4% of survivors reporting at least one pregnancy after cancer) among reproductive-aged cancer survivors despite cancer treatment having a potentially negative impact on reproductive potential.[8–10]

Factors associated with cancer survivors having an unplanned pregnancy after cancer included black race, age <30 years at diagnosis, and receipt of fertility counseling at cancer diagnosis. Some of the factors associated with unplanned pregnancy in cancer survivors are also seen in the general population, such as black race and young age.[6] In the general population, lower income is associated with risk of unplanned pregnancy,[6] while annual income was associated with unplanned pregnancy among cancer survivors in our unadjusted analysis; it was no longer associated with un-

planned pregnancy after adjusting for age and race. However, additional factors related to cancer were predictive of unplanned pregnancy in adjusted models, such as having an unplanned pregnancy before cancer or receiving fertility counseling during cancer treatment, and these factors may help identify which cancer survivors are in greatest need of contraception counseling.

Cancer survivors in our study were more likely to have an unplanned pregnancy after cancer than survivors in a small study that collected information about unplanned pregnancy.[19] Of 295 cancer survivors in that study, only 31 reported a pregnancy after cancer. Of those with a postcancer pregnancy, 16% reported an unplanned pregnancy. However, the median length of follow-up in that study was only 2.4 years (interquartile range [IQR]: 1.1–5.1 years) compared with 7 years (IQR: 5–11 years) in our study.

Pregnancy intent is a complex and multifactorial issue, especially among reproductive-aged cancer survivors.[32,33] Some survivors may feel conflicted about their ongoing survival and desire for parenthood.[34] Cvancarova et al.[35] reported that women with a history of cancer were half as likely to have a pregnancy after cancer as cancer-free women, and they found that postcancer reproduction was affected by age at diagnosis, parity at diagnosis, and time since

diagnosis, with the strongest association being childlessness at diagnosis.[35] However, they were unable to distinguish planned and unplanned pregnancies. We found that being younger at diagnosis was associated with a higher probability of having an unplanned pregnancy after cancer among survivors. We did not see an association between unplanned pregnancy and parity at diagnosis in our main analysis.

Some have hypothesized that cancer survivors are at high risk of unplanned pregnancy due to less frequent use of contraception compared with women without cancer.[16,19,36] In our study, cancer survivors were less likely than comparison women to have used contraception in the past year. However, they were not more likely to report an unplanned pregnancy. Decreased fertility in cancer survivors[8–10] may partially explain why our results do not support the hypothesis in the literature.

Nevertheless, cancer survivors could benefit from patient-centered counseling on risk and available contraceptive options that address their specific situation.[37] One study found that survivors who received contraceptive counseling were more likely to use Tier I/II methods.[20,38] However, providers may not be adequately counseling cancer survivors about contraception. One study reported that only 57% of gynecological oncologists believed that their patients understood that unplanned pregnancy was possible during and after cancer treatment.[39] Furthermore, 30% of gynecological oncologists did not routinely provide fertility or contraception counseling following cancer and 19% reporting that they only routinely provided fertility counseling.[39] In a study that reviewed medical records, only 45% of initial consultations documented a contraceptive plan in reproductive-aged patients.[40] The content of counseling is important because our study suggests that fertility counseling is associated with an increased risk of unplanned pregnancy following cancer treatment, a finding seen in both our primary analysis, as well as in our supplemental analysis, among only breast cancer survivors.

Cancer survivors, particularly those who undergo pelvic or total body irradiation or systemic chemotherapy, are more likely to experience permanent treatment-related amenorrhea.[11–15] Although women who resumed menses following cancer treatment were at a greater risk of an unplanned pregnancy following cancer diagnosis, unplanned pregnancies also occurred among women whose menses never returned.

Women may overestimate the risk of becoming postmenopausal as a result of treatment.[4] The majority of cancer survivors remain fertile after treatment.[41] In cancer patients <30 years treated with standard chemotherapy regimens, POF is more common than in the general population but is still rare.[18,42] Some argue that ovarian function should be reassessed following cancer treatment.[36] However, assessment of ovarian function following treatment may have limited utility because pregnancy has been reported in cancer survivors despite amenorrhea and follicle-stimulating hormone levels suggestive of menopause.[41]

We defined unplanned pregnancy as pregnancy occurring when using contraception and pregnancies occurring when women were not trying to get pregnant despite not using contraception. Pregnancies occurring when women were "neither trying nor not trying" to get pregnant were not counted as unplanned. However, this group may be noteworthy. One study found that ambivalence toward pregnancy is more likely among women >30 years at the time of pregnancy, those who report being nonwhite, and those who report a personal or religious objection to abortion.[43] In addition, a large proportion of women (30%–56%) report ambivalence about childbearing at the time of their last pregnancy.[43] We found that of the women with a pregnancy after cancer, only 4.1% of them reported a pregnancy for which they were neither trying nor not trying, suggesting a low level of ambivalence among survivors in our study.

Breast cancer survivors may be a unique group with respect to unplanned pregnancy and contraceptive use following cancer. Cancer type has previously been associated with a risk of unintended pregnancy, with breast cancer survivors being at increased risk compared to other cancers.[16] However, risk of unplanned pregnancy in that study was defined as having unprotected intercourse rather than actual incidence of unplanned pregnancy.[16]

We found that breast cancer survivors were less likely than other survivors to report a pregnancy after cancer, but among breast cancer survivors reporting a pregnancy after diagnosis, there was a high proportion of unplanned pregnancies (61.3%). Given the hormone-sensitive nature of some breast cancers, women with a history of breast cancer may fear using hormonal contraception in the absence of counseling about which contraception is safe for them and which should be avoided.

Unplanned pregnancies are often viewed as problematic in the public health literature, in part, due to their association with adverse prenatal and peripartum outcomes.[44,45] However, unplanned pregnancy does not necessarily mean a pregnancy is unwanted or unwelcome.[46,47] In addition, feelings about pregnancy may change over time.[48,49] Given that some cancer survivors may be infertile or experience a shortened window in which to have children after cancer while others may continue to be fertile, cancer survivors may benefit from tailored counseling that incorporates information about both fertility planning, fertility services, and contraception options to help them achieve their desired number and spacing of pregnancies.

Strengths and limitations

Our study has many strengths. We recruited a large number of cancer survivors of various cancers. We were able to compare cancer survivors to comparison women with regards to rates of unplanned pregnancy after cancer diagnosis using a proxy date of diagnosis for those with no history of cancer. The median time from cancer diagnosis to the interview was 7.0 years, allowing time for women to become pregnant with planned and unplanned pregnancies. In addition, we performed many sensitivity analyses to investigate factors associated with unplanned pregnancy among groups that may have differential risk.

Our study has some limitations. Our data are based on self-report. As time passes after a child's birth, parents may be less likely to describe the pregnancy as an unplanned pregnancy.[43] Therefore we may underestimate the number of women who actually had an unplanned pregnancy. However, we have no reason to believe that cancer survivors or comparison women would be more likely to recall a pregnancy as unplanned. Nevertheless, the probability of reporting a pregnancy as unplanned may differ by some participant

characteristics, including low income, young age, cohabitating, race, and education.[50] It is unclear whether these factors are associated with actual risk of unplanned pregnancy or with acceptability of referring to a pregnancy as unplanned.

These data were collected in 2012–2013; it is possible that patterns in contraceptive counseling among cancer survivors have evolved since then. In addition, we were unable to evaluate use of certain methods of nonhormonal contraception, such as condoms or a partner's vasectomy, as these questions were not included in the interview. Furthermore, pregnancy intention was assessed using a simplified measure of pregnancy intention, which may be less valid compared to psychometrical validated measures such as the London Measure of Unplanned Pregnancy.[51,52]

Conclusion

Rates of unplanned pregnancy after cancer were not higher for our cancer survivors compared with our comparison group, but nearly one-half of cancer survivors who had a pregnancy following cancer reported an unplanned pregnancy. Therefore, cancer patients may still benefit from counseling before cancer treatment that includes patient-centered screening and a discussion of postcancer reproductive care that integrates information regarding risks of infertility with risks of unplanned pregnancy following treatment, including access to family planning resources and contraceptive options.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or Centers for Disease Control and Prevention.

Authors' Contributions

Conceptualization: [L.M.S., J.B.S., P.P.H.]; Methodology: [L.M.S., L.M.K., P.P.H.]; Formal analysis and investigation: [L.M.S., L.M.K., P.P.H.]; Writing—original draft preparation: [L.M.S., P.P.H.]; Writing—review and editing: [J.B.S., D.M., A.C.M.]; Funding acquisition: [P.P.H.]; Supervision: [P.P.H.].

Author Disclosure Statement

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Supplementary Material

Supplementary Table S1

References

1. American Cancer Society. Estimated number of new cases for the four major cancers by sex and age group, 2020. Available at: https://www.cancer.org/content/dam/cancer-org/research/cancer-facts-and-statistics/annual-cancer-facts-and-figures/2020/estimated-number-new-cases-by-sex-and-age-group-2020.pdf Accessed February 24, 2020.

2. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2020. CA Cancer J Clin 2020;70:7–30.

3. American Cancer Society. Cancer Facts & Figures 2016. Atlanta: American Cancer Society, 2016.

4. Partridge AH, Gelber S, Peppercorn J, et al. Web-based survey of fertility issues in young women with breast cancer. J Clin Oncol 2004;22:4174–4183.

5. Bond CB, Jensen PT, Groenvold M, et al. Prevalence and possible predictors of sexual dysfunction and self-reported needs related to the sexual life of advanced cancer patients. Acta Oncol 2019;58:769–775.

6. Finer LB, Zolna MR. Declines in unintended pregnancy in the United States, 2008–2011. N Engl J Med 2016;374:843–852.

7. Kopeika J, Bhaduri M, Kugadas A, et al. Planned and unplanned pregnancies in breast cancer survivors. Breast 2019;46:75–80.

8. Mahajan N. Fertility preservation in female cancer patients: An overview. J Hum Reprod Sci 2015;8:3–13.

9. Levine J, Kelvin J, Quinn G, et al. Infertility in reproductive-age female cancer survivors. Cancer 2015;121:1532–1539.

10. Letourneau J, Chan S, Rosen M. Accelerating ovarian age: Cancer treatment in the premenopausal woman. Semin Reprod Med 2013;31:462–468.

11. Wallace WH, Thomson AB, Saran F, et al. Predicting age of ovarian failure after radiation to a field that includes the ovaries. Int J Radiat Oncol Biol Phys 2005;62:738–744.

12. Meirow D, Biederman H, Anderson RA, et al. Toxicity of chemotherapy and radiation on female reproduction. Clin Obstet Gynecol 2010;53:727–739.

13. Anderson RA, Themmen AP, Al-Qahtani A, et al. The effects of chemotherapy and long-term gonadotrophin suppression on the ovarian reserve in premenopausal women with breast cancer. Hum Reprod 2006;21:2583–2592.

14. Su H, Sammel M, Velders L, et al. Association of cyclophosphamide drug-metabolizing enzyme polymorphisms and chemotherapy-related ovarian failure in breast cancer survivors. Fertil Steril 2010;94:645–654.

15. Dillon K, Sammel M, Prewitt M, et al. Pretreatment anti-müllerian hormone levels determine rate of posttherapy ovarian reserve recovery: Acute changes in ovarian reserve during and after chemotherapy. Fertil Steril 2013;99:477–483.

16. Quinn MM, Letourneau JM, Rosen MP. Contraception after cancer treatment: Describing methods, counseling, and unintended pregnancy risk. Contraception 2014;89:466–471.

17. Partridge AH, Gelber S, Peppercorn J, et al. Fertility and menopausal outcomes in young breast cancer survivors. Clin Breast Cancer 2008;8:65–69.

18. Jacobson MH, Mertens AC, Spencer JB, et al. Menses resumption after cancer treatment-induced amenorrhea occurs early or not at all. Fertil Steril 2016;105:765–772 e764.

19. Dominick SA, McLean MR, Whitcomb BW, et al. Contraceptive practices among female cancer survivors of reproductive age. Obstet Gynecol 2015;126:498–507.

20. Britton L. Unintended pregnancy: A systematic review of contraception use and counseling in women with cancer. Clin J Oncol Nurs 2017;21:189–196.

21. Medica ACO, Stark SS, Hadnott TN, et al. Use of emergency contraception among female young adult cancer survivors. Fertil Steril 2018;109:1114–1120 e1111.

22. Karaoz B, Aksu H, Kucuk M. A qualitative study of the information needs of premenopausal women with breast cancer in terms of contraception, sexuality, early menopause, and fertility. Int J Gynaecol Obstet 2010;109:118–120.

23. Murphy D, Klosky JL, Termuhlen A, et al. The need for reproductive and sexual health discussions with adolescent and young adult cancer patients. Contraception 2013;88:215–220.

24. Howards PP, Mink PJ, Kim KH, et al. Comparison of young adult female cancer survivors recruited from a population-based cancer registry to eligible survivors. Cancer Epidemiol Biomarkers Prev 2021;30:727–735.

25. Georgia Department of Public Health. Georgia Comprehensive Cancer Registry: Policy and Procedure Manual for Reporting Facilities, Atlanta, GA, 2014.

26. Westreich D, Greenland S. The table 2 fallacy: Presenting and interpreting confounder and modifier coefficients. Am J Epidemiol 2013;177:292–298.

27. Lawson AK, McGuire JM, Noncent E, et al. Disparities in counseling female cancer patients for fertility preservation. J Womens Health (Larchmt) 2017;26:886–891.

28. Quinn DA, Sileanu FE, Zhao X, et al. History of unintended pregnancy and patterns of contraceptive use among racial and ethnic minority women veterans. Am J Obstet Gynecol 2020;223:564 e561–e564 e513.

29. Newman LM, Berman SM. Epidemiology of STD disparities in African American communities. Sex Transm Dis 2008;35:S4–S12.

30. Hogben M, Leichliter JS. Social determinants and sexually transmitted disease disparities. Sex Transm Dis 2008;35:S13–S18.

31. Centers for Disease Control and Prevention. STDs in racial and ethnic minorities, 2017. Available at: https://www.cdc.gov/std/stats17/minorities.htm Accessed January 26, 2019.

32. Schmidt R, Richter D, Sender A, et al. Motivations for having children after cancer—A systematic review of the literature. Eur J Cancer Care (Engl) 2016;25:6–17.

33. Trivers KF, Fink AK, Partridge AH, et al. Estimates of young breast cancer survivors at risk for infertility in the U.S. Oncologist 2014;19:814–822.

34. Ghaemi SZ, Keshavarz Z, Tahmasebi S, et al. Conflicts women with breast cancer face with: A qualitative study. J Family Med Prim Care 2019;8:27–36.

35. Cvancarova M, Samuelsen SO, Magelssen H, et al. Reproduction rates after cancer treatment: Experience from the Norwegian radium hospital. J Clin Oncol 2009;27:334–343.

36. Patel A, Sreedevi M, Malapati R, et al. Reproductive health assessment for women with cancer: A pilot study. Am J Obstet Gynecol 2009;201:191 e191–e194.

37. Mody SK, Panelli DM, Hulugalle A, et al. Contraception concerns, utilization and counseling needs of women with a history of breast cancer: A qualitative study. Int J Womens Health 2017;9:507–512.

38. Maslow BS, Morse CB, Schanne A, et al. Contraceptive use and the role of contraceptive counseling in reproductive-aged women with cancer. Contraception 2014;90:79–85.

39. Crafton SM, Lynch CD, Cohn DE, et al. Reproductive counseling, contraception, and unplanned pregnancy in fertile women treated by gynecologic oncologists. Gynecol Oncol Rep 2017;19:22–26.

40. Crafton S, Nekkanti S, Lynch C, et al. Documentation of pregnancy risk assessment and pregnancy among women presenting for gynecologic oncology consultation. Int J Gynecol Cancer 2016;26:35–42.

41. Patel A, Schwarz EB, Society of Family P. Cancer and contraception. Release date May 2012. SFP Guideline #20121. Contraception 2012;86:191–198.

42. Goodwin PJ, Ennis M, Pritchard KI, et al. Risk of menopause during the first year after breast cancer diagnosis. J Clin Oncol 1999;17:2365–2370.

43. Schwarz EB, Lohr PA, Gold MA, et al. Prevalence and correlates of ambivalence towards pregnancy among non-pregnant women. Contraception 2007;75:305–310.

44. Dye T, Wojtowyz M, Dozier A, et al. 728: Should unwanted pregnancy be considered a high-risk perinatal condition? Am J Obstet Gynecol 2013;208:S306.

45. Cheng D, Schwarz EB, Douglas E, et al. Unintended pregnancy and associated maternal preconception, prenatal and postpartum behaviors. Contraception 2009;79:194–198.

46. Aiken AR. Happiness about unintended pregnancy and its relationship to contraceptive desires among a predominantly Latina cohort. Perspect Sex Reprod Health 2015;47:99–106.

47. Aiken AR, Dillaway C, Mevs-Korff N. A blessing I can't afford: Factors underlying the paradox of happiness about unintended pregnancy. Soc Sci Med 2015;132:149–155.

48. Joyce T, Kaestner R, Korenman S. The stability of pregnancy intentions and pregnancy-related maternal behaviors. Matern Child Health J 2000;4:171–178.

49. Shreffler KM, Greil AL, Mitchell KS, et al. Variation in pregnancy intendedness across U.S. women's pregnancies. Matern Child Health J 2015;19:932–938.

50. Guttmacher Institute. Unintended Pregnancy in the United States, 2019. New York, NY: Guttmacher Institute, 2019.

51. Santelli J, Rochat R, Hatfield-Timajchy K, et al. The measurement and meaning of unintended pregnancy. Perspect Sex Reprod H 2003;35:94–101.

52. Barrett G, Smith SC, Wellings K. Conceptualisation, development, and evaluation of a measure of unplanned pregnancy. J Epidemiol Community Health 2004;58:426–433.

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