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Fertility education for adolescent cancer patients: Gaps in current clinical practice in Europe

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Abstract

Objective: As adolescent cancer patients may suffer from infertility following treatment, fertility counselling is essential. Our aim was to explore the current situation in four European countries in terms of (I) education about the risk for infertility, (II) counselling on fertility preservation, (III) patients' knowledge on fertility, (IV) sufficiency of information and (V) uptake of cryopreservation.

Methods: In total, 113 patients (13–20 years) at 11 study centres completed a self-report questionnaire three and six months after cancer diagnosis. Multivariate logistic regression was used to estimate odds ratios (OR) with 95% confidence intervals (CI).

Results: As many as 80.2% of participants reported having received education about the risk for infertility prior to treatment, 73.2% recalled counselling on fertility preservation. Only 52.3% stated they felt sufficiently informed to make a decision. Inability

to recall counselling on fertility preservation (OR = 0.03, CI: 0.00–0.47) and female gender (OR = 0.11, CI: 0.03–0.48) was associated with lower use of cryopreservation, whereas older age was associated with higher use.

Conclusion: Fertility counselling was available to a relatively high proportion of patients, and it did influence the utilisation of cryopreservation. However, many patients did not feel sufficiently informed. Further improvement is needed to enable adolescent cancer patients to make an informed decision on fertility preservation.

KEYWORDS

adolescent cancer patients, cryopreservation, fertility education, fertility impairment, fertility preservation, shared decision-making

1 | INTRODUCTION

In view of the increasing long-term survival rates in children and adolescents with malignant diseases (Gatta et al., 2014; Kaatsch, Grabow, & Spix, 2016), minimisation of late effects is necessary to improve quality of life for survivors. Infertility is one potential late effect. Cancer treatment can lead to fertility impairment in about one third of patients (Balcerek, Reinmuth, Hohmann, Keil, & Borgmann-Staudt, 2012; Rendtorff et al., 2010) and in over two thirds following haematopoietic stem cell transplantation (Borgmann-Staudt et al., 2012). The risk of infertility depends on diagnosis, age at the time of treatment and treatment regimen (Reinmuth et al., 2013; Wallace, Anderson, & Irvine, 2005).

Clinical practice guidelines recommend timely discussion of cancer-related infertility and available fertility preservation options, and/or referral to a reproductive specialist to provide the opportunity to undertake fertility preservation (Oktay et al., 2018). Fertility preservation should be pursued prior to cancer treatment. Sperm cryopreservation is a well-established method for post-pubertal male patients (American Society for Reproductive Medicine et al., 2013; Romao & Lorenzo, 2017; Skinner et al., 2017). Options for females include cryopreservation of unfertilised or fertilised oocytes for post-pubertal patients, or surgical transposition of the ovaries outside of the pelvic radiation field (American Society for Reproductive Medicine et al., 2013; Dittrich et al., 2018; Lobo, 2005). Ovarian tissue cryopreservation remains experimental in prepubertal girls and is deemed innovative in post-pubertal females (Balduzzi et al., 2017), but it may evolve to become standard therapy in the future (Oktay et al., 2018).

Adolescent cancer patients wish to be fully informed about treatment effects on fertility and preservation options, but parents and healthcare professionals sometimes underestimate the importance of fertility to them (Barlevy, Wangmo, Elger, & Ravitsky, 2016; Cherven, Mertens, Wasilewski-Masker, Williamson, & Meacham, 2016). Survivors often do not recall having been informed about the risk for infertility at diagnosis (Cherven et al., 2016; Loi et al., 2010) and report uncertainty about their fertility after treatment (Benedict, Shuk, & Ford, 2016; Zebrack, Casillas, Nohr, Adams, & Zeltzer, 2004). Clinicians often do not deliver oncofertility support to the standard of current guidelines, and as such many patients of reproductive age may lack the oncofertility support that they require (Logan, Perz, Ussher, Peate, & Anazodo, 2018a). Providing a sensitive and proactive fertility discussion may be beneficial to social well-being (Skaczkowski et al., 2018) and patients feel supported when their fertility information and service needs are met (Logan, Perz, Ussher, Peate, & Anazodo, 2018b).

Rates of fertility preservation in adolescent patients vary: in a study conducted among 43 survivors who were diagnosed with cancer between 14 and 18 years of age, five males and no females underwent fertility preservation before treatment (Benedict et al., 2016). Klosky et al. (2017) reported that among 146 adolescent males newly diagnosed with cancer, 53.4% made a collection attempt and 43.8% successfully banked sperm. In another study among 550 adolescent and young adult cancer survivors diagnosed between the ages of 15 and 39 years, 49% of the males and 22% of the females took steps to preserve fertility (Bann et al., 2015). As fertility preservation remains underutilised in the paediatric and adolescent population, further research is needed to reduce the number of missed opportunities (McCracken & Nahata, 2017).

1.1 | Objectives

To explore the current practice of fertility education for adolescent cancer patients in four European countries, we examined: (I) availability of counselling on the risk for infertility prior to cancer treatment, (II) availability of counselling on fertility preservation options, (III) patients' overall knowledge on fertility, (IV) patients' perception of feeling sufficiently informed to take informed decisions and (V) uptake of cryopreservation. This survey was the first part of a broader intervention study on fertility education in these countries, which received funding within the European project PanCareLIFE (Byrne et al., 2018).

2 | METHODS

2.1 | Patient recruitment

Patients were recruited from March 2014 until January 2016 in the following 11 paediatric oncology departments: Medical University of Graz (Austria); University Hospital Brno and Motol Teaching Hospital Prague (Czech Republic); Medical Faculty of the Heinrich-Heine-University Düsseldorf, University Medical Center Ulm, Münster University Hospital, Charité – Universitätsmedizin Berlin, University Medical Center Schleswig-Holstein and Helios Klinikum Berlin-Buch (Germany); Medical University of Bialystok and Medical University of Gdansk (Poland). All patients admitted to the participating clinics within the study period who met the eligibility criteria were invited by a clinician to participate in the study three months after their initial diagnosis. This time-point was chosen to leave the patient some room to come to terms with the situation of cancer diagnosis.

2.2 | Eligibility criteria

All newly diagnosed female and male patients aged ≥13 years who were treated according to any therapy regimen that included chemotherapy and/or radiation in a participating paediatric oncology department were eligible. Patients with poor prognosis, relapse or secondary malignancy were excluded, as well as patients with cognitive impairment and those who were unable to understand the given national language.

2.3 | Sample description

In the period of data collection, 142 patients met the inclusion criteria; 16 declined participation, 5 were deceased, 2 had poor health status at time of surveying and 6 were excluded due to other reasons. Thus, 113 patients were enrolled in the study, resulting in a response rate of 79.6%. No significant differences were found between responders and non-responders regarding gender, age at the time of diagnosis and cancer diagnosis.

2.4 | Ethics and data protection

The coordinating study centre Charité – Universitätsmedizin Berlin received approval from the local ethics committee (EA2/155/11). All data providers received approval for the study from their respective ethics committees. Patient data were pseudonymised.

2.5 | Study procedures

Three (t0) and six (t1) months after initial diagnosis, participants completed a self-report questionnaire which included 38 items on received patient education, knowledge about fertility and fertility preservation, as well as socioeconomic data. The paper-based questionnaires were completed by participants in person at clinic appointments (study questionnaires available online: https://kinderonkologie.charite.de/forschung/ag_borgmann_staudt/pancarelife_interventionstudy_patient_education_2013_2018/). We concentrated on the following five areas of interest:

To evaluate patient education concerning the risk for infertility and fertility preservation, the following questions were analysed:

(I) "Prior to your treatment, were you informed about the potential risk of hormonal problems, including fertility impairment, following cancer treatment?"
"If yes, with whom did you speak about this?"
"If yes, did you have to request this information yourself?"

(II) "Prior to your treatment, were you informed about possibilities to preserve your fertility?"
"If yes, with whom did you speak about this?"
"If yes, did you have to request this information yourself?"

Agreement with the following statement was analysed to assess if participants felt sufficiently informed, with answer options ranging from "strongly agree", "agree", "neither agree nor disagree" to "disagree" and "strongly disagree":

(III) "I feel sufficiently informed by the information given to me to make a decision for myself"

(IV) Knowledge was tested using six multiple-response questions on risk factors for infertility, signs of fertility, types of hormone replacement treatment, artificial reproductive techniques and fertility preservation measures before and after puberty with a total of 37 answers. For each correct answer, two points were assigned to ensure enough variance for statistical analysis, with a range from 0 to 74 points. A participant was classified as having sufficient knowledge if he or she achieved at least 50% of the maximum score (≥37 points).

(V) The treating physician stated whether cryopreservation had been pursued prior to cancer therapy or not. All data providers gave information on availability of fertility preservation in their countries: sperm banking was available in all countries. Cryopreservation of oocytes and testicular tissue was only available in Germany, and ovarian tissue cryopreservation only in Austria and Germany. Ovarian transposition was available in the Czech Republic and Germany.

Furthermore, participants estimated their infertility risk by stating "low," "medium" or "high" to the question "How do you perceive your personal risk of fertility impairment caused by your cancer treatment?". Participants' core data, including diagnosis and treatment, were obtained from medical records. To represent participants' educational background, the highest educational/vocational degree of the parents was stratified into three educational status groups (low, intermediate and high), determined

according to the International Standard Classification of Education (ISCED 97).

2.6 | Statistics

Data analysis was conducted with SPSS Statistical Software Version 24. In order to examine (I) recall of education about the risk for infertility, (II) recall of counselling on fertility preservation, (III) participants' feeling of being sufficiently informed, (IV) their knowledge about fertility and (V) utilisation of cryopreservation, multiple univariate analyses with the variables gender, age group, diagnosis, country in which treated and participants' perceived infertility risk were conducted using chi-squared tests with alpha < 5%. Additionally, recall of risk education and recall of fertility preservation counselling were correlated with the participants' feeling of being sufficiently informed, their knowledge about fertility and their uptake of cryopreservation. Differences in attained knowledge between female and male participants were tested by using a two-tailed *t* test for independent samples with $\alpha = .05$. For the assessment of differences in knowledge between t0 and t1, a paired samples two-tailed *t* test with $\alpha = .05$ was used. Effect size was measured by calculating Cohen's *d*. For multivariate analyses of determinants of participants' knowledge and utilisation of cryopreservation, binary logistic regression was used to estimate odds ratios (OR) with 95% confidence intervals (CI). The modelling concerning utilisation of cryopreservation included gender, age group, diagnosis, country in which treated, participants' perceived infertility risk, recall of risk education and recall of fertility preservation counselling. The modelling concerning knowledge included gender, age, diagnosis, country in which treated, educational background, recall of risk education and recall of fertility preservation counselling. To ensure statistical power, the attending clinics were grouped by country to control for specific between-country differences.

TABLE 1 Participant characteristics

	Participants (n = 113)
Gender	
Male	60 (53.1%)
Female	53 (46.9%)
Age group	
13–15 years	41 (36.3%)
16–17 years	39 (34.5%)
18–20 years	33 (29.2%)
Country in which treated	
Austria	10 (8.8%)
Czech Republic	48 (42.5%)
Germany	42 (37.2%)
Poland	13 (11.5%)
Diagnosis (main groups)	
Leukaemia/lymphoma	62 (54.9%)
Brain tumours	5 (4.4%)
Solid tumours	45 (39.8%)
Other	1 (0.9%)
Diagnosis (details)	
Leukaemia	18 (15.9%)
Lymphoma	44 (38.9%)
Brain tumours	5 (4.4%)
Bone tumours	22 (19.5%)
Soft tissue tumours	8 (7.1%)
Liver tumours	1 (0.9%)
Germ cell tumours	13 (11.5%)
Carcinoma	1 (0.9%)
Other	1 (0.9%)

3 | RESULTS

3.1 | Participant characteristics

Out of the 113 participants, 60 (53.1%) were male and the mean age at cancer diagnosis was 15.42 years (age range from 12 to 19 years). At time of completion of the first questionnaire (t0), which was collected after a mean time of 3.13 months after diagnosis, the mean age was 16.18 years (age range from 13 to 20 years). The second questionnaire (t1) was completed by 106 participants (93.8%) after a mean time of 6.05 months after diagnosis. Participant characteristics are described in Table 1. Where not otherwise specified, the results refer to the data collected from the first questionnaire (t0).

3.2 | Education about the risk for infertility (I)

In total, 80.2% of participants recalled having been informed about the risk of infertility prior to cancer treatment. The majority (98.9%) stated they had received this information from their physician and only one participant had been informed by another, unspecified, person. Six participants (6.9%) said that they had had to ask for the information themselves. Univariate analyses showed that the age group of 13- to 15-year-olds recalled having been informed less often than older participants ($p < .05$; Table 2). In regard to gender, diagnosis, country in which treated and participants' perceived infertility risk, no differences were found.

3.3 | Counselling on fertility preservation (II)

Receiving information on fertility preservation options was recalled by 73.2% of participants, of whom 97.6% stated that they had been informed by their physician and two participants had been informed by another, unspecified, person. Only one participant (1.3%) reported having needed to ask for this information. No significant differences were found regarding gender, diagnosis, country in which treated and the participants' perceived infertility risk (Table 2). A trend towards significance was seen for age

TABLE 2 Results of univariate analysis (t0)

	Education about the risk for infertility: yes		Counselling on fertility preservation: yes		Feeling sufficiently informed: agree		Utilisation of cryopreservation: yes	
	Frequency	*p*-Value	Frequency	*p*-Value	Frequency	*p*-Value	Frequency	*p*-Value
Gender	*n* = 111		*n* = 112		*n* = 109		*n* = 113	
Male	49 (83.1%)	.419	46 (76.7%)	.375	34 (58.6%)	.057	28 (46.7%)	**.001**
Female	40 (76.9%)		36 (69.2%)		23 (45.1%)		9 (17.0%)	
Age group	*n* = 111		*n* = 112		*n* = 109		*n* = 113	
13–15 years	25 (64.1%)	**.007**	24 (60.0%)	.06	12 (31.6%)	**.026**	7 (17.1%)	**.023**
16–17 years	34 (87.2%)		32 (82.1%)		23 (60.5%)		15 (38.5%)	
18–20 years	30 (90.9%)		26 (78.8%)		22 (66.7%)		15 (45.5%)	
Diagnosis (main groups)	*n* = 110		*n* = 111		*n* = 108		*n* = 112	
Leukaemia/lymphoma	48 (78.7%)	.238	44 (71.0%)	.146	30 (50.8%)	.427	18 (29.0%)	.53
Brain tumours	2 (50.0%)		2 (40.0%)		1 (20.0%)		1 (20.0%)	
Solid tumours	38 (84.4%)		35 (79.5%)		25 (56.8%)		17 (37.8%)	
Country in which treated	*n* = 111		*n* = 112		*n* = 109		*n* = 113	
Czech Republic	40 (85.1%)	.719	38 (80.9%)	.261	23 (48.9%)	.066	17 (35.4%)	.544
Poland	10 (76.9%)		7 (53.8%)		7 (53.8%)		2 (15.4%)	
Austria	8 (80.0%)		7 (70.0%)		5 (50.0%)		3 (30.0%)	
Germany	31 (75.6%)		30 (71.4%)		22 (56.4%)		15 (35.7%)	
Participants' perceived infertility risk	*n* = 106		*n* = 107		*n* = 105		*n* = 107	
Low	25 (75.8%)	.725	23 (67.6%)	.67	18 (54.5%)	.09	8 (23.5%)	.277
Medium	39 (83.0%)		36 (76.6%)		25 (54.3%)		17 (36.2%)	
High	21 (80.8%)		19 (73.1%)		12 (46.2%)		11 (42.3%)	
Education about the risk for infertility	—		—		*n* = 108		*n* = 111	
Yes					55 (63.2%)	**<.001**	35 (39.3%)	**.007**
No/don't know					2 (9.5%)		2 (9.1%)	
Counselling on fertility preservation	—		—		*n* = 109		*n* = 112	
Yes					50 (61.7%)	**<.001**	36 (43.9%)	**<.001**
No/don't know					7 (25.0%)		1 (3.3%)	
Total	*n* = 111		*n* = 112		*n* = 109		*n* = 113	
	89 (80.2%)	—	82 (73.2%)	—	57 (52.3%)	—	37 (32.7%)	—

Note: [a]Significant *p* values (< .05) are in bold.

(*p* = .06), with older participants recalling having been informed slightly more often.

3.4 | Feeling sufficiently informed (III)

Almost half (47.7%) of all participants did not feel sufficiently informed to decide on their own. This did not differ according to cancer diagnosis, country in which treated or the participants' perceived infertility risk. Univariate analyses showed that participants who recalled having received information regarding the risk for infertility (*p* < .01) and fertility preservation (*p* < .01) stated more often that the given information had enabled them to make a decision (Table 2). Compared with older participants, 13- to 15-year-olds felt insufficiently informed more often (*p* < .05). Furthermore, there was a trend towards significance for gender (*p* = .057) and for the country in which treated (*p* = .066).

3.5 | Participants' knowledge about fertility (IV)

At t0, 60.4% of females and 25.0% of males were classified as having attained sufficient knowledge. The difference in mean scores of knowledge between females (37.85) and males (33.63)

TABLE 3 Knowledge—results of univariate analysis (t0, t1)

	Knowledge: 50% or more			
	t0		t1	
	Frequency	*p*-Value	Frequency	*p*-Value
Gender	*n* = 113		*n* = 104	
Male	15 (25.0%)	**<.001**	20 (35.7%)	**.012**
Female	32 (60.4%)		29 (60.4%)	
Age group	*n* = 113		*n* = 104	
13–15 years	15 (36.6%)	.708	20 (54.1%)	.257
16–17 years	17 (43.6%)		13 (36.1%)	
18–20 years	15 (45.5%)		16 (51.6%)	
Country in which treated	*n* = 113		*n* = 104	
Czech Republic	13 (27.1%)	**.005**	20 (46.5%)	**.014**
Poland	3 (23.1%)		1 (7.7%)	
Austria	6 (60.0%)		6 (60.0%)	
Germany	25 (59.5%)		22 (57.9%)	
Educational background (household)	*n* = 108		*n* = 99	
Low	3 (37.5%)	.274	4 (50.0%)	.070
Medium	15 (33.3%)		13 (33.3%)	
High	27 (49.1%)		30 (57.7%)	
Education about the risk for infertility	*n* = 111		*n* = 104	
Yes	43 (48.3%)	**.010**	41 (48.8%)	.478
No/don't know	4 (18.2%)		8 (40.0%)	
Counselling on fertility preservation	*n* = 112		*n* = 104	
Yes	38 (46.3%)	.061	38 (49.4%)	.441
No/don't know	8 (26.7%)		11 (40.7)	
Total—Knowledge: 50% or more	*n* = 113		*n* = 104	
	47 (41.6%)	—	49 (47.1%)	—

Note: [a]Significant *p* values (< .05) are in bold.

was significant ($p < .01$, $d = 0.52$). In addition to gender ($p < .01$), univariate analyses showed significant differences for recall of receiving risk information ($p < .05$) and for the country in which treated ($p < .05$; Table 3). Logistic regression confirmed these effects; female gender (OR = 5.90, CI: 2.08–16.79) and recalling information on the risk for infertility (OR = 6.20, CI: 1.13–34.11) were predictors for achieving sufficient knowledge (Table 4). Receiving treatment in the Czech Republic (OR = 0.17; CI: 0.05–0.53) or Poland (OR = 0.12, CI: 0.02–0.67) was associated with not achieving sufficient knowledge. At t1, both females and males showed an increase in mean scores of knowledge between the two survey time-points, but this was significant only for males ($p < .05$, $d = 0.265$).

TABLE 4 Predictors for sufficient knowledge—results of binary logistic regression (t0)

	Knowledge: 50% or more (*n* = 105)			
			95% CI	
	p-Value	OR	Lower	Upper
Gender: female	**.001**	**5.904**	**2.076**	**16.792**
Age of patient (in years)	.565	1.096	0.803	1.496
Country in which treated: Czech Republic	**.002**	**0.166**	**0.052**	**0.526**
Country in which treated: Poland	**.016**	**0.122**	**0.022**	**0.672**
Country in which treated: Austria	.210	3.477	0.496	24.387
Educational background (household): medium	.259	3.095	0.434	22.051
Educational background (household): high	.156	4.016	0.59	27.363
Education about the risk for infertility: yes	**.036**	**6.201**	**1.127**	**34.113**
Counselling on fertility preservation: yes	.842	1.149	0.293	4.495

Note: Coding of dependent variable: 0 = less than 50%, 1 = 50% or more. Reference: Gender: male; Country in which treated: Germany; Educational background (household): low; Education about the risk for infertility: no/don't know; Counselling on fertility preservation: no/don't know. Nagelkerke $R^2 = .439$.

Significant *p* values (< .05) are in bold.

3.6 | Utilisation of cryopreservation (V)

Almost half (46.6%) of males and less than one fifth (17.0%) of females used cryopreservation, according to the information given by their physicians. In addition to gender ($p < .01$), univariate analyses showed significant differences regarding age ($p < .05$) and recall of information on fertility preservation ($p < .01$; Table 2). Multivariate regression confirmed these effects; female gender (OR = 0.11, CI: 0.03–0.48) and inability to recall information regarding fertility preservation options (OR = 0.03, CI: 0.00–0.47) were predictors for lower utilisation, whereas the age of 18–20 years (OR = 5.31, CI: 1.29–21.89) was associated with an increased likelihood of cryopreservation (Table 5).

4 | DISCUSSION

This study was the first to systematically collect data on adolescent cancer patients' recall of receiving fertility education in four

TABLE 5 Predictors for utilisation of cryopreservation—results of binary logistic regression

	Utilisation of cryopreservation (n = 105)			
			95% CI	
	p-Value	OR	Lower	Upper
Gender: female	**.003**	**0.114**	**0.027**	**0.477**
Age group: 16–17 years	.213	2.431	0.601	9.840
Age group: 18–20 years	**.021**	**5.311**	**1.289**	**21.885**
Diagnosis: brain tumours	.861	1.327	0.055	31.829
Diagnosis: solid tumours	.652	0.761	0.233	2.486
Country in which treated: Czech Republic	.109	0.356	0.101	1.260
Country in which treated: Poland	.075	0.135	0.015	1.226
Country in which treated: Austria	.232	0.318	0.049	2.080
Participants' perceived infertility risk: medium	.281	2.035	0.558	7.416
Participants' perceived infertility risk: high	.903	1.094	0.259	4.620
Education about the risk for infertility: no/don't know	.732	1.581	0.114	21.887
Counselling on fertility preservation: no/don't know	**.012**	**0.031**	**0.002**	**0.470**

Note: Coding of dependent variable: 0 = no, 1 = yes. Reference: Gender: male; Age group: 13–15 years, Diagnosis: leukaemia/lymphoma, Country in which treated: Germany; Participants' perceived infertility risk: low; Education about the risk for infertility: yes; Counselling on fertility preservation: yes. Nagelkerke R^2 = .434.

Significant p values (< .05) are in bold.

different European countries. The response rate was high: 79.6% of all adolescent cancer patients newly diagnosed at 11 study clinics who met the inclusion criteria participated in our study. Three months after diagnosis, the majority of participants reported having received education regarding the risk for infertility and fertility preservation prior to cancer treatment. This is a promising result. Earlier studies estimated a much lower percentage (Hohmann et al., 2011; Zebrack et al., 2004). Several factors may have contributed to this. Firstly, data presented in these studies were collected from survivors who were diagnosed longer ago than our study cohort, possibly increasing recall bias. Secondly, overall in recent years, infertility and fertility preservation in cancer patients have been focus of research resulting in various guidelines. Therefore, physicians nowadays are more likely to have a better knowledge basis for their patient education. Thirdly, the participating study centres' physicians might have had a stronger focus on fertility education, being aware of the ongoing study.

In our study, younger participants recalled having been informed about the risk of infertility less often than older participants. Younger participants may not remember as much of the complex information, but it is also possible that they received patient education less often. Vadaparampil, Quinn, King, Wilson, and Nieder (2008) described age being a barrier in the physician's decision to pass on information about the risk of infertility and fertility preservation. Younger patients also may have been more likely to have had fertility information communicated directly to a parent. This may build the case for integrating age-appropriate informational materials in fertility education for younger patients.

Gender-related differences in patient education were not found in the current study, in accordance with Hohmann et al. (2011), possibly reflecting the approach by healthcare providers to inform female and male patients equally. Previous studies reported that male patients received fertility education more often, which might be explained by the comparably better availability of effective fertility preservation strategies for males (Cherven et al., 2016; Yeomanson, Morgan, & Pacey, 2013).

Although recall of education was generally high, almost half of the participants felt that they were not sufficiently informed to make a decision of their own. This suggests that even though patients seem to receive fertility education, the quality needs to be improved. In an earlier study, Oosterhuis, Goodwin, Kiernan, Hudson, and Dahl (2008) found that only 35.1% of adolescent cancer patients were satisfied with the amount of information they received about possible treatment effects on fertility. This increase might be indicative of an improving trend in fertility counselling. Although not statistically significant, especially females did not feel sufficiently informed. An explanation may be that healthcare providers have different knowledge about preservation options for male and female patients (Vesali, Navid, Mohammadi, Karimi, & Omani-Samani, 2019) and young women tend to receive incomplete information (Wright, Coad, Morgan, Stark, & Cable, 2014).

Half of all males used cryopreservation, whereas a much smaller proportion of females did. Previous studies have also shown lower utilisation rates of fertility preservation for female compared with male patients among adolescent and young adult cancer patients (Bann et al., 2015; Benedict et al., 2016; Shnorhavorian et al., 2015). This difference may be explained by the fact that sperm cryopreservation is a safe, reliable and easily available method of fertility preservation in post-pubertal males (Romao & Lorenzo, 2017; Skinner et al., 2017). In contrast, cryopreservation of oocytes in post-pubertal females requires hormonal stimulation and therefore delays the start of cancer treatment, which can be prohibitive with most adolescent malignancies (Dittrich et al., 2018; Romao & Lorenzo, 2017). Ovarian tissue cryopreservation can be performed immediately, but it is more surgically invasive (Lobo, 2005) and carries the risk of possible retransplantation of cancer cells (Dittrich et al., 2018; Dolmans, Luyckx, Donnez, Andersen, & Greve, 2013). Furthermore, for female adolescent patients the availability of fertility preservation options may be limited, such as in the participating study centres in the Czech Republic and Poland.

For prepubertal patients, cryopreservation remains experimental, as cryopreservation of gonadal tissue is the only available option at present (American Society for Reproductive Medicine et al., 2013; Dittrich et al., 2018; Romao & Lorenzo, 2017). Considering that these procedures provide limited chances of having biological offspring, fertility preservation decisions may be more challenging for parents who are making this decision for their child (Li, Jayasinghe, Kemertzis, Moore, & Peate, 2017). Successful fertility preservation is yet to reach its full potential (David, Green, & Shikanov, 2017), although medical advances do offer realistic hope for the possibility of biological offspring to patients who were diagnosed with cancer before or during puberty (Ho et al., 2017; Prasath et al., 2014).

Our finding that inability to recall discussion of fertility preservation was associated with a lower use of cryopreservation underlines the importance of fertility counselling. Adolescents and parents value discussing fertility concerns and preservation options despite facing the challenges of a cancer diagnosis (Taylor & Ott, 2016). In our study, three months after first completing the questionnaire, knowledge about fertility had increased, suggesting that participants have been made aware of this topic by the study and may have searched for further information or have talked to healthcare providers or parents.

Despite existing guidelines, many physicians do not discuss fertility preservation with every patient. Quality and frequency of fertility discussions may be improved by training on recognition of personal biases and communication skills, as well as involvement of the entire healthcare team (Quinn et al., 2009). The introduction of a fertility preservation toolkit for clinicians has shown significant improvements in clinicians' confidence to provide up-to-date information on fertility preservation and in provision of verbal and written information to patients (Kemertzis et al., 2018). To support parents of children and adolescents in making informed fertility-related decisions, a decision aid has been found to be relevant and acceptable by parents and clinicians, and parents reported an improved understanding of infertility and fertility preservation procedures (Allingham et al., 2018).

The implementation of a standardised process for sperm banking for male adolescent and young adult cancer patients has been associated with increased rates of sperm cryopreservation (Shnorhavorian, Kroon, Jeffries, & Johnson, 2012), as well as consultation with a fertility specialist (Klosky et al., 2017). A systematic review has identified core components of an oncofertility model of care: services should have safe and reliable referral pathways, provide age-appropriate care, and include medical and psychological care from diagnosis through to survivorship (Anazodo et al., 2019). Implementing fertility-related psychological support into standard practice may benefit patients and survivors greatly, as reproductive concerns and unfulfilled desire for a child were linked to higher rates of mental health disorders and psychological distress (Logan, Perz, Ussher, Peate, & Anazodo, 2019).

Efforts should be made to incorporate fertility counselling into routine cancer care for every adolescent patient, enabling them to make an informed decision on fertility preservation and thus increase chances of having biological offspring, if desired. Nevertheless, fertility preservation is still not equally available and affordable (Rashedi et al., 2018; Shenfield et al., 2017) and remains challenging in female and prepubertal patients.

4.1 | Limitations

To avoid selection bias, inclusion and exclusion criteria were applied consecutively to all newly diagnosed adolescent cancer patients coming to the 11 participating centres during the study period. To check for self-selection bias, basic non-responder data were also collected. Non-responders were comparable to responders regarding gender, age and cancer diagnosis. Although non-responder data on other factors potentially affecting self-selection (such as curative prospects, infertility risks or education level) were not available, we assume—in view of the high response rate—that they could not have a major impact on our results in the five research areas of our interest. As participants self-reported fertility education, it cannot be determined whether participants who did not recall being informed about fertility risks and fertility preservation actually had not received such consultation or did not remember. The stress of being informed about a potentially lethal disease can negatively affect memory due to dysfunctional information processing (Kangas, Henry, & Bryant, 2005). We did not capture whether participants might not have personally desired further information with information being given to a parent and whether participants wanted to be able to make a decision wholly themselves. Despite having been instructed to perform patient education "as usual," the physicians who treated and educated the study participants might have discussed fertility issues particularly well. Regarding the use of fertility preservation, it is important to note that the participating centres have different fertility preservation measures available at different cost for the patients. Furthermore, the level of maturity influences the feasibility of fertility preservation options and we did not assess participants' pubertal status in our study. Results that are close to the limit of significance may not be reliable due to our small sample size and should be considered only indicative. Further research on larger sample sizes might result in significant findings.

5 | CONCLUSION

A relatively high proportion of participants were able to recall receiving information about the risk for infertility and fertility preservation from their treating physician prior to cancer treatment. However, gaps seem to exist as many patients did not feel sufficiently informed and younger patients recalled receiving fertility education less often. Our study indicates that those who do receive information use fertility preservation more often, whereas

younger or female patients were less likely to do so. In addition to ensuring that every adolescent cancer patient receives fertility counselling, fertility preservation has to be both available and affordable, and research into extending fertility preservation options is needed.

CONFLICT OF INTEREST

None.

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