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ARTICLE

Attitudes toward genetic testing in childhood and reproductive decision-making for familial adenomatous polyposis

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Childhood DNA testing, prenatal diagnosis (PND) and preimplantation genetic diagnosis (PGD) are available for familial adenomatous polyposis (FAP). However, the use of PND and PGD is controversial. The purpose of this study was to investigate attitudes toward, and experiences with, childhood DNA testing, PND and PGD among members of families at high risk for FAP. In this nationwide, cross-sectional study, questionnaires were sent to individuals from families at high risk for FAP assessing attitudes toward and experiences with childhood testing, PND and PGD, as well as several sociodemographic, clinical and psychosocial variables. Of the individuals from FAP families invited to participate in the study, 525 members participated (response rate=64%). Most parents who had children who were minors (n=93) (82%) were satisfied with the DNA testing procedure. One-third of all individuals wanted DNA testing for their children before age 12. Forty percent of FAP patients indicated that the disease influenced their desire to have children. Only 15% considered termination of pregnancy for FAP acceptable. Approximately 30% of individuals with a FAP diagnosis and their partners considered PND and PGD as acceptable for themselves. A positive attitude was associated with higher levels of guilt and a positive attitude toward termination of pregnancy. Importantly, of those with FAP at childbearing age, 84% had had no previous information at all about either PND or PGD. Future efforts should be aimed at educating FAP family members about reproductive options, allowing them to make an informed choice about family planning. Routine discussion of all reproductive options with a medical specialist should be encouraged.

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INTRODUCTION

Familial adenomatous polyposis (FAP) is an autosomal-dominant inherited disease, characterized by the development of multiple (>100) adenomas that, without surgery, will inevitably lead to colorectal cancer. Preventive colectomy is usually recommended between the ages of 15 and 25 years.[1] According to published guidelines, preoperative screening, colon examinations with flexible sigmoidoscopy, should be carried out at 2-year intervals from the age of 10 to 12 onwards.[2]

Genetic testing for FAP during childhood is available and can prevent needless endoscopic screening in noncarriers and facilitate timely endoscopic screening in carriers. In the past decade, genetic testing for hereditary cancer before birth has become available through prenatal diagnosis (PND) and preimplantation genetic diagnosis (PGD). PND is performed by chorionic villus sampling during early pregnancy (10–20 weeks). If the fetus is a carrier, the pregnancy can be terminated. PGD is a technique that involves *in vitro* fertilization (IVF) with a biopsy at the six- to eight-cell stage of the embryo, 3 days after insemination. Only unaffected embryos are transferred to the uterus.[3] Although both PND and PGD for hereditary cancer have been available for a number of years, ethical concerns have been raised about both procedures. PGD for hereditary cancer is particularly controversial and is still not widely used.[4–7] Lavery *et al*[8] found that PGD users (for diseases other than FAP) and who also had experience with PND reported that the experience of PND followed by termination had a negative impact and that PGD is a potentially valuable alternative. Although the first PGD procedures for FAP were already performed in 1998,[3] the availability of both PND and PGD for FAP still varies between countries.

Few studies have assessed parents' attitudes toward genetic testing of children or toward the use of PND and PGD for hereditary cancer. Two studies among FAP patients reported that acceptability of both childhood testing and reproductive techniques such as PND and PGD are high, although not many would proceed to termination of pregnancy.[9,10] These previous studies had several limitations, sample sizes were typically small, and only affected individuals[9,10] were

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investigated. Also, the study of Whitelaw *et al*[10] was performed before predictive genetic testing and PGD were readily available, thus making their results less relevant for the current FAP population.

In this large, nationwide, cross-sectional study, we report on attitudes toward childhood DNA testing, PND and PGD among carriers, individuals at risk, and noncarriers from FAP families. We also investigated the experiences of parents with DNA testing of their children (<18 years) and experiences with the use of PND and PGD. Finally, we investigated possible sociodemographic, clinical and psychosocial factors associated significantly with attitudes toward PND and PGD.

METHODS

Study sample

Participants were drawn from the FAP registry of the Netherlands Foundation for the Detection of Hereditary Tumours (NFDHT). Eligible participants were those who were (a) 16 years of age or older and (b) who were FAP patients (having a clinically and/or genetically proven diagnosis), at 50% risk of inheriting FAP, or a proven noncarrier. We also invited the partners of FAP patients to participate.

Procedures

Invitation letters were sent to contact persons within a family. These were typically a family member who had assisted in drafting the family pedigree at the time of registration, and were often a key figure within the family with regard to counseling issues. The contact persons were asked to (1) complete a self-report questionnaire and (2) assist in inviting other family members by mail to participate in the study. In some families, more than one contact person was recruited because of the large number of family members (and branches within the family).

Questionnaires were mailed between October 2005 and January 2007, with a reminder letter sent after 2 weeks. Self-reported clinical data were confirmed by medical record audits whenever possible. The study was approved by the ethics committee of the Netherlands Cancer Institute and the advisory board of the NFDHT.

Measures

Where available we made use of validated questionnaires. When this was not possible we used study-specific questions based on the literature, which were pilot tested on a small sample of patients for readability and understanding.

Sociodemographic and clinical variables. The self-report questionnaire assessed gender, age, education, number of children and the desire to have (more) children. Data on time since surgery, DNA testing and family cancer history were collected through self-report and medical records.

Attitudes toward DNA testing in childhood. Respondents were asked to indicate their personal opinion about the most appropriate age at which children should undergo DNA testing. The response categories were the following: '0–5 years, 6–11 years, 12–15 years, or 16 years and older'. To assess the preferred timing of genetic testing of children in FAP families, we asked respondents to choose between the following three options: (1) 'it should be possible for all children from one family to undergo DNA testing at the same time', (2) 'every child should be tested individually at a fixed age' or (3) 'children should not undergo DNA testing'.

Experiences with DNA testing of children. If respondents had children for whom DNA testing had been performed, they were asked a series of questions about the DNA testing procedure: Who, if anyone, informed the children about the DNA test results? What were the reasons for not telling the children their DNA test result? How satisfied were they with the counseling process? Did they receive sufficient support and, if not, would they have liked to have received more support?

Influence of FAP on desire to have children. Questions were posed to all FAP patients about current desire to have (more) children, and if FAP had an influence on their desire in this regard.

Attitudes toward PND and PGD. The questionnaire included a short, introductory text about PND and PGD:

> Prenatal diagnosis includes DNA testing for the hereditary predisposition for FAP of the unborn child during pregnancy. If the child is found to be a carrier of the hereditary predisposition, termination of the pregnancy (abortion) can be considered. A new method, which is not (yet) possible for everyone, is preimplantation genetic diagnosis (PGD). This diagnostic technique takes place after *in vitro* fertilization, also called IVF. A hereditary abnormality, if present, can be found three days after fertilization of the ovum. Only embryos without the hereditary abnormality are placed in the uterus, after which pregnancy can develop normally.

After reading this introduction, respondents were asked if they would consider PND or PGD for a potential future pregnancy. Response categories were 'definitely', 'probably', 'don't know', 'probably not' and 'definitely not'. The higher the score the more negative the attitude.

We also asked respondents to imagine a pregnancy within their own family and asked them what would be their attitude toward termination of pregnancy: (1) in general, (2) if the fetus had Down syndrome or (3) if the fetus was a carrier for FAP (based on the study by Lodder *et al*[11]). For each category, respondents were asked 'Do you find termination of pregnancy acceptable?' Response categories were 'yes', 'no' or 'unsure'.

Experiences with PND and PGD. Respondents were asked if they had personal experience with PND and, if so, if this had led to termination of the pregnancy. When termination was reported, respondents were asked about the effect of this termination on their partner relationship (questions based on the study by Lavery *et al*[8]). Individuals were also asked if a physician had ever spoken with them about PND or PGD, and if they would like to have (more) information on either PND or PGD.

Psychosocial variables. The questionnaire also assessed a number of psychosocial variables (Table 1): involvement in the disease process of a relative, generalized, cancer- and FAP-specific distress, risk perception and feelings of guilt. Variables were selected based on previous studies on attitudes toward PND and PGD.[8,9,18,19]

Data analysis

Descriptive statistics were used to characterize the study sample. Univariate analyses (χ^2-test, Fisher's exact test, Student's *t*-test and analysis of variance) were used to investigate which sociodemographic, clinical and psychosocial variables were related significantly to attitudes toward either PND or PGD. For correlational analyses, Pearson's *r* was used.

Regression analyses were carried out to determine which variables were associated significantly with attitudes toward PND and PGD at the multivariate level. As attitudes toward PND and PGD among individuals with a FAP diagnosis were found to be correlated within families, we used a multilevel approach to the regression analyses. All variables that showed at least a marginally significant ($P<0.10$) association with attitudes at the univariate level were entered into the regression analyses.

RESULTS

Sample characteristics

A total of 830 individuals from FAP families were invited to participate in the study, of whom 525 (64%) returned a completed questionnaire. Compared with nonrespondents, respondents were significantly more likely to be female (54 *vs* 42%; $P<0.01$) and older (43.6 (SD=14.1) *vs* 41.3 (SD=15.8) years); $P<0.05$).

In total, 153 partners were invited to participate in the study (with consent of the FAP patient), of whom 131 (86%) returned a completed questionnaire. Table 2 displays the sociodemographic and clinical characteristics of the study sample.

Table 1 Psychosocial measures

Variable	*No. of items (scoring)*	*α*[a]	*Reference*	*Description of questions*
Involvement in care of a family member with cancer	1 (five-point scale: not at all to very strongly involved)	—	Based on a questionnaire used in an earlier study of individuals counseled for Lynch syndrome[12]	Participants were asked to report the extent to which they were involved in the disease process of one or more of their relatives with colorectal cancer
Generalized distress	5 (total: 0–100)	—	Mental health scale (MHI-5), a subscale of the SF-36[13]	'Have you been a very nervous person?' 'Have you felt calm and peaceful?'
Cancer-specific distress	8 (four-point scale: never to almost always)	0.88	Based on studies by Lerman *et al*[14] and Watson *et al*[15] Two items were added, assessing worries about family members and future surgery	The six original items address worries about developing cancer and the influence of worries on daily life. Two added items address worries about family members and future surgery (see Table 3)
FAP-specific distress	7 (four-point scale: 0, never; 1, seldom; 3, sometimes; 5, often) Sum score rating of distress: 0–8 low; 9–19 moderate; ≥20 severe	0.90	Intrusion subscale of the Impact of Event Scale[16]	Event=Me or my family having FAP 'I had waves of strong feelings about it.' 'Pictures about it popped into my mind' Severe distress is an indication of pathological levels of distress
Risk perception	1 (five-point scale: lower to much higher)	—	Item adapted from Lerman *et al*[17]	Respondents were asked to report their perceived risk of developing cancer (again) relative to that of the 'average person of your age in the Dutch population'
Feelings of guilt	1 (four-point scale: not at all to very much)	—	Self-developed	Respondents were asked if they have felt guilty during the last 6 months about having FAP and the possibility of passing it on to one's children. Partners were asked if they have felt guilty during the last 6 months about being healthy whereas their partner has FAP

Abbreviations: FAP, familial adenomatous polyposis.
[a]Cronbach's alpha.

Attitudes toward childhood genetic testing

Thirty-four percent of respondents felt that it was most suitable to DNA test children for FAP when under the age of 12 years, whereas 38% preferred ages of 12–16 (Table 3). There were no statistically significant differences observed between patients, those at risk, noncarriers and partners in this regard (P=0.21). Among those who preferred an older age (12 years or older) at testing, the dominant reason was 'wanting the child to be able to understand the DNA testing process'.

Fifty-two percent believed that every child should be tested individually (at a fixed age), whereas 37% felt that it was preferable that all children from a family be tested at the same time. Only 4% of respondents felt that children should not undergo DNA testing at all. There were no statistically significant differences between patients, individuals at risk, noncarriers and partners on this variable (P=0.08).

Experiences with childhood genetic testing

Ninety-three individuals with a FAP diagnosis and 43 partners had children who were minors (<18 years) during the DNA testing process. Sixty-six individuals (72%) with a FAP diagnosis reported that the clinical geneticist had explained the DNA test results to the children (with or without the parents being present). Nineteen parents (20%) had informed their children themselves of the DNA test results without the presence of a physician; in eight of these, all of the children tested were noncarriers; in four all were carriers and in seven there was a mix of carriers and noncarriers. Four individuals (4%) had not yet informed their children of the test results, either because they felt that their children were too young or because they were noncarriers.

Eighty-one percent of individuals with a FAP diagnosis and 77% of partners were (very) satisfied with the counseling process. The most frequently suggested addition to the current support was the opportunity to talk with someone who had already gone through the process.

Influence of FAP on the desire to have children

Thirty-seven percent (n=118; mean age 39.4) of FAP patients indicated that the hereditary nature of FAP or the expectation of becoming ill in the future influenced their desire to have children (ie, wanting less or no children). Thirty-nine percent of FAP patients (mean age 40.1) indicated that FAP had not influenced their desire, whereas the remaining 25% indicated that they had not been aware of their FAP diagnosis at the time of family planning.

Attitudes toward termination of pregnancy

As shown in Table 4, 29% of respondents felt that termination of pregnancy is 'unacceptable' in general, whereas 38% felt that it is 'acceptable' under certain circumstances. Acceptability of pregnancy termination varied significantly among respondent subgroups, with more partners (50%) reporting a favorable attitude than FAP patients (34%), individuals at risk (34%) or noncarriers (36%) (P=0.02).

Table 2 Characteristics of the respondents

	Individuals from FAP families (n=525)		*Partners (n=131)*	
	Mean (range)	*SD*	*Mean (range)*	*SD*
Age	43.6 (16–84)	14.1	46.0 (21–79)	11.5
	N	*%*	*N*	*%*
Gender				
Male	242	46	65	50
Female	283	54	66	50
Level of education				
Primary school/basic vocational school	175	33	29	22
High school	269	51	73	56
College or university	79	15	28	22
Missing	2	—	1	—
Children				
Yes	338	64	96	73
No	187	36	35	27
Childbearing age				
Yes (≤40 years)	242	46	49	37
No (>40 years)	283	54	82	63
Personal cancer history				
Yes	45	9	4	3
No	480	91	127	97
Actual risk				
FAP patients[a]	341	65	—	
At risk for FAP[b]	50	10	—	
Noncarrier	134	26	—	
Time since last surgery				
No surgery, because noncarrier	134	26	—	
No surgery (yet)	95	18	—	
0–1 year	16	3	—	
1–2 years	16	3	—	
2–5 years	33	6	—	
5–10 years	73	14	—	
More than 10 years	158	30	—	
Time since receiving DNA test result				
No DNA testing	163	31	—	
0–1 year	8	2	—	
1–2 years	27	5	—	
2–5 years	41	8	—	
5–10 years	96	18	—	
More than 10 years since DNA test result	14	29	—	
DNA test result not (yet) available	9	2	—	
Missing	27	5	—	

Abbreviation: FAP, familial adenomatous polyposis.
[a]Individuals with a diagnosis confirmed by a positive DNA test results and/or by the clinical finding of more than 100 polyps.
[b]Individuals at a 50% risk without polyps with an inconclusive DNA test result (n=2) or who have not undergone DNA testing (yet).

Twenty-three percent of respondents felt that termination of pregnancy for Down syndrome is 'acceptable', whereas 35% indicated that it is 'unacceptable'. There were no significant differences between patients, individuals at risk, noncarriers and partners on this variable (P=0.14).

Fourteen percent of respondents felt that termination of pregnancy for FAP is 'acceptable', whereas 52% indicated that it is 'unacceptable'. There were no significant differences between patients, individuals at risk, noncarriers and partners (P=0.44) in this regard.

Attitudes toward PND and PGD

Questions about attitudes toward the use of PND and PGD were posed only to FAP patients. These questions were left unanswered by 85 (25%) and 82 (24%) of FAP patients, respectively. Compared with respondents, nonrespondents were significantly more likely (1) to be 45 years or older (32 *vs* 80%; $P<0.001$ for PND; and 33 *vs* 80%; $P<0.001$ for PGD) and (2) not to have a current desire to have children (55 *vs* 82%; $P<0.001$ for PND and 55 *vs* 81%; $P<0.01$ for PGD).

Thirty-three percent (n=85) of individuals with a FAP diagnosis reported a positive attitude (answered 'would definitely or probably undergo PND') toward PND and 30% (n=76) reported a positive attitude toward PGD.

Table 5 displays variables associated with attitudes toward PND and PGD at the univariate level. For both PND and PGD, at the multivariate level, higher levels of guilt (P=0.02, β=0.145 and P=0.003, β=0.180; respectively) and positive attitude toward termination of pregnancy (P=0.000, β=0.322 and P=0.000, β=0.255; respectively) were associated significantly with a more positive attitude toward PND, accounted for 15 and 11% of the variance in attitude, respectively.

Multivariate analyses for those of childbearing age (<40) showed that a positive attitude toward PND was associated significantly with having no children (β=0.174) and having a positive attitude toward termination of pregnancy (β=0.209), whereas a positive attitude toward PGD was associated significantly with more feelings of guilt (β=0.185).

Attitude of partners toward PND and PGD

Twenty-four percent (n=20) and 32% (n=27) of partners reported a positive attitude toward PND and PGD, respectively.

At the univariate level, a more positive attitude toward PND was significantly associated with younger age ($P<0.05$) and having second-degree relatives (SDRs) with cancer ($P<0.05$). Because of the large number of missing data (>10%) for 'SDRs with cancer', we did not carry out a regression analysis.

Multivariate regression analyses showed that a positive attitude toward PGD was associated significantly with higher educational level (β=0.335; P=0.01) and a positive attitude toward termination of pregnancy (β=0.238; P=0.02), accounting for 23% of the variance in attitude.

Concordance between patients' and partners' attitudes toward PND and PGD

Seventy percent of couples shared the same attitude toward PND and 64% toward PGD. Among the discordant couples, the partner had a more positive attitude toward PND and PGD in 56% of the cases.

Experiences with PND and PGD

Of the 157 respondents with FAP at childbearing age (<40 years), 84% reported to have had no information at all about either PND or

Table 3 Attitudes toward DNA testing during childhood (*n*=656)

	Total (n=656)	*Patients (n=341)*	*At risk (n=50)*	*Noncarriers (n=134)*	*Partners of patients (n=131)*
Most suitable age for children to be tested (years)					
0–5	76 (12%)	32 (9%)	4 (8%)	18 (13%)	22 (17%)
6–11	144 (22%)	79 (23%)	7 (14%)	29 (22%)	29 (22%)
12–15	249 (38%)	128 (38%)	16 (32%)	52 (39%)	53 (41%)
16 and older	141 (22%)	77 (23%)	16 (32%)	26 (19%)	22 (17%)
Missing	46 (7%)	25 (7%)	7 (14%)	9 (7%)	5 (4%)
Statement on testing children separately or at same time					
It should be possible to get all children tested at the same time	243 (37%)	117 (34%)	18 (36%)	48 (36%)	60 (46%)
Every individual child should be tested at a fixed age	341 (52%)	192 (56%)	23 (46%)	63 (47%)	63 (48%)
Children should not undergo DNA testing	25 (4%)	10 (3%)	1 (2%)	10 (8%)	4 (3%)
Missing	47 (7%)	22 (7%)	8 (16%)	13 (10%)	4 (3%)

Table 4 Attitudes toward termination of pregnancy (*n*=656)

	Total (n=656)	*Patients (n=341)*	*At risk (n=50)*	*Noncarriers (n=134)*	*Partners of patients (n=131)*
In the case of a pregnancy in my family					
Termination of pregnancy is unacceptable in every situation					
Yes	193 (29%)	106 (31%)	12 (24%)	38 (28%)	37 (28%)
No	247 (38%)	116 (34%)	17 (34%)	48 (36%)	66 (50%)
Don't know	153 (23%)	84 (25%)	15 (30%)	36 (27%)	18 (14%)
Missing	63 (10%)	35 (10%)	6 (12%)	12 (9%)	10 (8%)
Termination of pregnancy is acceptable if the fetus has Down syndrome					
Yes	153 (23%)	80 (24%)	9 (18%)	32 (24%)	32 (24%)
No	227 (35%)	110 (32%)	13 (26%)	45 (34%)	59 (45%)
Don't know	208 (32%)	114 (33%)	19 (38%)	44 (33%)	31 (24%)
Missing	68 (10%)	37 (11%)	9 (18%)	13 (10%)	9 (7%)
Termination of pregnancy is acceptable if the fetus is carrier of the genetic mutation causing FAP					
Yes	93 (14%)	52 (15%)	3 (6%)	20 (15%)	18 (14%)
No	339 (52%)	174 (51%)	22 (44%)	69 (52%)	74 (57%)
Don't know	153 (23%)	76 (22%)	16 (32%)	33 (25%)	28 (21%)
Missing	71 (11%)	39 (11%)	9 (18%)	12 (9%)	11 (8%)

Abbreviation: FAP, familial adenomatous polyposis.

PGD; 8% reported to have had information about both techniques. Twenty percent expressed interest in receiving more information on both techniques.

Five respondents had had previous experience with PND. Two of these individuals had undergone termination of pregnancy because of carriership (one individual had two terminations). In one of the three cases in which the pregnancy was continued, the couple chose to have their child despite carriership for FAP.

We did not ask respondents about experiences with PGD, as this technique was not available in the Netherlands for FAP at the time of our study. However, one respondent reported spontaneously that she had had three unsuccessful PGD procedures abroad.

DISCUSSION

Childhood DNA testing, PND and PGD are available for familial adenomatous polyposis (FAP) in most Western countries. However, the use of PND and PGD is controversial. This is one of the first studies to investigate the opinions of FAP family members on testing of children during childhood, and attitudes toward and experiences with the use of PND and PGD for FAP.

One important finding of our study was that approximately one-third of FAP family members had a preference for testing their children before the medically recommended age of 12 years. Whitelaw *et al*[10] reported that almost all individuals would like to have their children tested at birth. Adolescence is generally seen as a particularly

Table 5 Univariate association of attitudes toward PND and PGD with sociodemographic, clinical and psychosocial variables of individuals with a FAP diagnosis (*n*=341)

	Attitude toward PND			*Attitude toward PGD*		
	Mean[a]	*SD*	P-*value*	*Mean*[a]	*SD*	P-*value*
	3.4	1.5		3.2	1.5	
Sociodemographic variables						
Gender						
Male	3.3	1.5	0.47	3.1	1.4	0.11
Female	3.5	1.6		3.4	1.5	
Education						
Low	3.5	1.5	0.17	3.3	1.5	0.64
Moderate	3.4	1.5		3.2	1.5	
High	2.9	1.5		3.0	1.4	
Age						
Correlation	0.19		**0.002**	0.14		**0.02**
Childbearing age						
Yes (≤40 years)	3.2	1.5	**0.02**	3.1	1.4	0.22
No (>40 years)	3.7	1.6		3.4	1.5	
Children						
Yes	3.5	1.6	0.13	3.3	1.5	0.35
No	3.2	1.5		3.1	1.4	
Current desire to have children						
Yes/maybe	3.1	1.4	**0.01**	3.0	1.3	**0.05**
No	3.6	1.6		3.4	1.6	
Clinical variables						
DNA testing performed						
Yes	3.3	1.5	0.15	3.1	1.5	0.08
No	3.6	1.6		3.5	1.5	
Cancer history						
Yes	3.6	1.6	0.45	3.7	1.4	0.06
No	3.4	1.5		3.2	1.5	
First-degree relatives with cancer						
Yes	3.5	1.5	0.30	3.2	1.5	0.79
No	3.2	1.6		3.2	1.5	
Second-degree relatives with cancer						
Yes	3.4	1.5	0.20	3.2	1.5	0.85
No	3.0	1.7		3.3	1.5	
Psychosocial variables						
Involvement in the care for a family member with cancer						
Correlation	0.04		0.53	−0.04		0.54
Cancer-specific distress						
Correlation	−0.05		0.44	−0.03		0.67
FAP-specific distress						
Low	3.5	1.5	0.25	3.3	1.4	0.19
Moderate to high	3.2	1.6		3.0	1.5	
Generalized distress						
Correlation	0.05		0.46	0.09		0.18
Risk perception						
Correlation	−0.11		0.09	−0.04		0.58
Guilt toward children[b]						
Correlation	−0.13		**0.04**	−0.16		**0.01**
Attitude toward termination of pregnancy in general						
Positive	2.9	1.6	**0.000**	2.9	1.5	**0.01**
Negative	3.8	1.4		3.6	1.4	
Don't know	3.6	1.4		3.3	1.4	

Abbreviations: FAP, familial adenomatous polyposis; PGD, preimplantation genetic diagnosis; PND, prenatal diagnosis.
[a]A higher score reflects a less positive attitude toward PND and PGD.
[b]Guilt: a higher score reflects less feeling of guilt. Bold values are significant at 0.05 level.

vulnerable period, so one could argue for performing DNA testing either during childhood or during young adulthood. However, as DNA testing is generally not recommended before it is medically necessary it is unlikely that parents' preferences for testing during childhood will have a significant influence on policy.[20]

The majority of individuals did not consider pregnancy termination as a viable option for FAP. Only 14% of FAP patients indicated that this was acceptable, as compared with 24% in the study by Whitelaw *et al*.[10]

The percentage of individuals with a FAP diagnosis in this study who had a positive attitude toward PND and PGD (33 and 30%, respectively) was much lower than that reported in two earlier studies. In these studies, 65[10] and 95%[9] of individuals were found to be positively inclined toward PND, and 90% toward PGD.[9] Two studies among women at risk for hereditary breast and ovarian cancer found that 36 and 57% of individuals had a positive attitude toward PGD,[18,19] whereas a third study reported that only 13% of BRCA1/2 carriers had a positive attitude toward PGD.[21] Possible explanations for the differences observed between studies in attitudes toward PND and PGD include the relatively small sample sizes of some of these studies, differences in information given about PND and PGD, selection bias (eg, only women or individuals visiting a conference), cultural differences (two studies were from the UK and three from the USA) and differences in the type of hereditary cancer under investigation (BRCA1/2 *vs* FAP).

Several limitations of this study should be noted. First, a relatively large number of participants did not answer the questions about PND and PGD. However, those who left these questions unanswered were primarily older individuals no longer in the childbearing age range. Therefore, we believe that our results reflect the attitudes of individuals for whom reproductive decision-making is still relevant.

Second, the study was carried out before PGD became officially available for the Dutch FAP population. Opinions may have changed after PGD became available and received media attention. In addition, we know that attitudes do not necessarily translate into actual behavior. In earlier studies on PND for Huntington's disease, the actual demand was much lower than would be expected based on studies assessing attitudes.[22,23] Therefore, we expect the actual uptake of PND and PGD to be lower than that reported by our respondents.

This study also had a number of specific strengths. First, to our knowledge this study is among the first to investigate attitudes toward reproductive decision-making for a treatable cancer syndrome with onset during childhood. Treatability of a disease is important in the ethical debate on the use of PND and PGD. Some argue that PND and/or PGD should not be offered for a disease that can be treated and that has low morbidity.[6,24,25] However, it is important to understand the attitudes of those directly affected by FAP. Second, our study also included partners and therefore provides a more complete picture from the perspective of the affected dyad. Third, to our knowledge, this is the largest study conducted, to date, of individuals from FAP families. This large sample size facilitated the use of multilevel multivariate analyses to identify variables associated significantly to attitudes toward PND and PGD. Such multilevel analyses also take into consideration the fact that more than one individual from any given family could be included in the study sample. Adjusting the data for this type of statistical dependency can be important.[26]

In summary, the results of this study indicate that most parents from FAP families were (very) satisfied with the DNA testing of their children. However, one-third would prefer DNA testing for their children before age 12. Although 40% of FAP patients indicated that the disease had influenced their desire to have children, only a small percentage (14%) considered termination of pregnancy for FAP to be acceptable. Self-reported acceptability of pregnancy termination in the case of Down syndrome was higher (23%). Approximately 30% of those with a FAP diagnosis had a positive attitude toward PND and PGD for FAP. Higher levels of guilt and a receptive attitude toward pregnancy termination were significantly associated with a positive attitude toward both PND and PGD.

Future prospective studies are needed to confirm the results reported here and to examine more carefully the attitudes toward reproductive decisions and the associated variables over time. Importantly, of the individuals with FAP at childbearing age, 84% were unfamiliar with PND and PGD before participation in our study. Future efforts should be aimed at educating FAP family members about reproductive options so that they can make an informed choice about family planning. Routine discussion of all reproductive options by a medical specialist, specifically geneticists, should be encouraged.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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