Scientific Reports

https://doi.org/10.1038/s41598-026-61177-3

Article in Press

Preimplantation genetic testing (PGT-M) awareness in BRCA-positive individuals in Türkiye: a dual physician–patient survey

Received: 27 April 2026

Accepted: 2 July 2026

Published online: 07 July 2026

Cite this article as: Cicin I., Bahsi T., Kose F. *et al.* Preimplantation genetic testing (PGT-M) awareness in BRCA-positive individuals in Türkiye: a dual physician–patient survey. *Sci Rep* (2026). https://doi.org/10.1038/s41598-026-61177-3

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Preimplantation Genetic Testing (PGT-M) Awareness in BRCA-Positive Individuals in Türkiye: A Dual Physician–Patient Survey

RUNNING TITLE: PGT Awareness in BRCA-Positive Individuals in Türkiye

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Abstract

Background

BRCA1/2 germline pathogenic variants confer markedly elevated lifetime risks for breast, ovarian, prostate, and pancreatic cancers. Preimplantation genetic testing for monogenic disorders (PGT-M) is an embryo-selection step performed within an in vitro fertilization (IVF) cycle that enables carriers to select embryos unaffected by the familial pathogenic variant, substantially reducing—though not eliminating—the risk of transmission. Despite regulatory approval by ESHRE since 2003 and accumulating evidence of clinical and cost-effectiveness, PGT-M remains systematically underutilized in Türkiye. This study aimed to simultaneously assess PGT-M knowledge and attitudes among physicians managing BRCA-positive individuals and among patients and carriers themselves, to quantify the knowledge-action gap, and to characterize PGT counseling practices

Methods

A cross-sectional dual-survey study was conducted including 206 physicians and 72 BRCA1/2-positive individuals. Descriptive statistics and subgroup comparisons were performed. Binary logistic regression identified factors associated with adequate physician knowledge.

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Results

Only 33.0% of physicians reported adequate perceived knowledge, whereas 80.1% considered it medically appropriate and 71.8% would recommend it, demonstrating a marked knowledge–attitude paradox. Excluding genetics and gynecology specialists, adequate perceived knowledge dropped to 16.2%. Among patients, 69.4% had never received PGT information during counseling, and only 16.7% would consider PGT. Younger patients (<40 years) showed numerically higher receptivity (28.6% vs. 11.8% in those aged ≥40 years), although this difference was not statistically significant.

Conclusion

In Turkish BRCA clinical practice, positive attitudes toward PGT coexist with substantial knowledge deficits. Patients under 40, who carry the greatest reproductive urgency and highest potential benefit from PGT, are more receptive but remain inadequately counseled. Integrating PGT into routine genetic counseling protocols, implementing specialty-targeted continuing medical education focusing on medical oncology and surgery, and establishing national oncofertility coordination may represent important strategies toward closing this gap.

Commented [AB1]: What group is this?

Keywords

BRCA1/2 mutation; preimplantation genetic testing; PGT-M; physician awareness; patient knowledge; knowledge-action gap; oncofertility; genetic counseling.

Introduction

Pathogenic germline variants in BRCA1 and BRCA2 genes substantially increase lifetime risks for breast, ovarian, prostate, and pancreatic cancers. Beyond individual cancer risk, the autosomal dominant inheritance pattern confers a 50% probability of transmission to each offspring, fundamentally shaping reproductive decision-making for carriers of reproductive age. Gonadotoxic treatments, the narrowing reproductive window imposed by risk-reducing salpingo-oophorectomy (RRSO), and emerging evidence of reduced ovarian reserve in BRCA1 carriers [1-4] add further reproductive complexity to an already demanding clinical trajectory.

Preimplantation genetic testing for monogenic disorders (PGT-M) offers a medically and ethically established pathway for BRCA1/2 carriers to select, within an IVF cycle, embryos unaffected by the familial pathogenic variant, thereby reducing—but not eliminating—the risk of transmission; results remain subject to test limitations (e.g., allele dropout, no-result embryos) and to the availability of unaffected embryos. The European Society of Human Reproduction and Embryology (ESHRE) Ethics Task Force extended PGT indications to late-onset and variable penetrance conditions — explicitly including BRCA1/2 — as early as 2003, [5] followed by formal regulatory approval from the UK Human Fertilisation and Embryology Authority in 2006

(HFEA, 2006). The American Society for Reproductive Medicine (ASRM) Ethics Committee reaffirmed in 2024 that PGT-M for adult-onset conditions conferring disease predisposition is ethically permissible. [6] By 2018, BRCA1 had become the second most frequent monogenic PGT indication globally, second only to Huntington disease. [7]

Cost-effectiveness analyses consistently support PGT-M for BRCA transmission prevention. Lipton et al. [8] demonstrated that IVF/PGT-M was cost-effective versus natural conception for both BRCA1 (probability 98.4%) and BRCA2 (97.3%) carriers, with discounted incremental cost-effectiveness ratios well within accepted thresholds. Independent modelling from Israel reached comparable conclusions. [9] Despite this evidence base, a persistent gap between awareness, acceptance, and actual uptake has been documented across multiple health systems. Nahshon et al., [10] in a cross-sectional survey of 530 BRCA1/2 carriers, found that whereas 58% accepted PGT as legitimate, only 8% had actually undergone it. Dervin et al. [11] reported that 86.2% of French carriers believed PGT-M should be systematically proposed, yet only 47.1% would consider it for themselves.

A distinct but equally important gap has been documented on the provider side. Capelouto et al. [12] found that while 88% of physicians agreed patients should receive PGT information, fewer than one in four discussed it in practice. Douma et al. [13] demonstrated that non-genetics health professionals have insufficient knowledge of hereditary cancer genetics, express educational needs, and are unprepared to counsel patients — with higher knowledge levels directly predicting greater communication confidence. Lombardi et al. [14] documented in an Italian BRCA1/2 carrier cohort that reproductive decisions, including the choice of PGT, are shaped by a combination of gender, informational, and psychological factors — reinforcing the point that patient-level uptake is constrained not only by access but by the adequacy of counseling received. These converging findings suggest that the knowledge gap is a structural educational phenomenon rather than a geography-specific one.

Commented [AB2]: Lombardi paper studies *patient decision making* rather than physician/provider view. Incorrect use of citation.

A particularly underexplored dimension is the age-specific urgency of PGT counseling. Reproductive medicine data establish that PGT-M success rates are highest when oocyte retrieval occurs before age 35–37, [15] and BRCA carriers are advised to complete childbearing before the recommended age for RRSO (35–40 years for BRCA1, ~40 for BRCA2). [4] This convergence creates a narrow reproductive window for young BRCA carriers in which PGT counseling carries maximal clinical relevance — yet whether this group receives proportionally better counseling remains unknown.

This study aimed to assess PGT-M awareness simultaneously from physician and patient/carrier perspectives in Türkiye; to quantify the knowledge-action gap and its specialty-specific determinants; to evaluate PGT counseling practices by patient age, diagnosis, and clinical setting; and to propose evidence-based recommendations for closing the identified gaps.

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While national surveys of physician knowledge of hereditary-cancer reproductive options exist [12–14], these have addressed providers alone. To our knowledge, no study has simultaneously evaluated both physician and patient awareness of PGT-M within a single national clinical setting, leaving the paired supply- and demand-side structure of this gap insufficiently characterized.

Materials and Methods

Study Design and Setting

This cross-sectional, dual-survey study was conducted. Two parallel self-administered online questionnaires were distributed: one targeting physicians, one targeting BRCA1/2-positive patients and carriers. No formal sample size calculation was performed; the study was designed as an exploratory national survey aiming to capture broad representation across specialties and patient groups. The study was approved by the Istinye University Ethics Committee (No. 2024/02, 24-56) and conducted in accordance with the Declaration of Helsinki. All participants provided informed consent prior to survey access. Only fully completed questionnaires were retained for analysis; partially completed submissions were excluded prior to analysis, yielding the final analytic samples of 206 physicians and 72 patients/carriers reported below.

Physician Cohort

Physicians actively involved in managing BRCA-related malignancies — including medical oncologists, general surgeons, gynecologists/gynecologic oncologists, urologists, medical geneticists, and radiation oncologists — were recruited via professional networks, email distribution, and academic society channels. Inclusion required current clinical involvement in BRCA-positive patient management in Türkiye.

Patient and Carrier Cohort

Individuals with a self-reported, previously documented BRCA1 or BRCA2 germline pathogenic variant were recruited through oncology clinics, patient advocacy networks, and social media. Participants included individuals with active cancer diagnoses and asymptomatic carriers. All participants were aged 18 or older and capable of providing informed consent. BRCA status was based on participant self-report of a prior positive genetic test; independent laboratory confirmation was not performed, and this group is therefore described throughout as self-reported BRCA1/2 carriers.

Survey Instruments

Both instruments were developed de novo by the multidisciplinary investigator team, were administered in Turkish, and are provided in full as Supplementary Material, in alignment with ESMO [16] and NCCN [17]

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guideline recommendations. The physician questionnaire (46 items) covered: demographics, specialty, experience, and practice setting; BRCA testing frequency, timing, and reimbursement access; self-assessed knowledge of test result interpretation, diagnosis/treatment/follow-up, and variants of uncertain significance (VUS); clinical practices regarding genetic counseling, multidisciplinary tumor board utilization, and screening/prophylactic surgery recommendations; and PGT knowledge, medical/ethical attitudes, and recommendation intent. The patient questionnaire (52 items) addressed: demographics, cancer diagnosis and staging; BRCA test process, timing, and financing; information adequacy and genetic counseling receipt; psychological impact; family communication; and specifically, whether PGT had been discussed during genetic counseling and whether the participant would consider PGT for a future pregnancy.

Outcome Variables

The primary physician-level outcomes were four PGT variables. Self-assessed PGT knowledge was recorded on a four-point Likert scale ranging from no knowledge to very knowledgeable. Physicians also reported whether they considered PGT medically appropriate, whether they considered it ethically and sociologically acceptable, and whether they intended to recommend it. Physician subgroup analyses were conducted by specialty, years of experience, and institution type. The primary patient-level outcomes were two PGT variables. The first was whether PGT had been discussed during the participant's genetic counseling, and the second was whether the participant would consider PGT in the event of a planned pregnancy. Subgroup analyses were performed by age group (under 40 vs. 40 and above; and four strata: <35, 35–39, 40–49, 50+), cancer diagnosis, and genetic counseling receipt.

Statistical Analysis

Descriptive statistics were reported as frequencies (n) and percentages (%). For the physician cohort, adequate PGT knowledge was defined as reporting 'sufficient' or 'very knowledgeable' (hereafter termed “adequate perceived knowledge,” as this reflects physician self-assessment rather than objective testing). Binary logistic regression was used to identify demographic and specialty factors independently associated with adequate knowledge. All candidate predictors—specialty group (with all other specialties combined as the reference category), years of experience (>10 vs. ≤10 years), institution type (private vs. public), age, and sex—were entered simultaneously (enter method), and odds ratios are reported with 95% confidence intervals. Ninety-five percent confidence intervals for proportions were calculated using the Wilson score method, and between-group comparisons of independent proportions used Fisher’s exact test. A p-value ≤0.05 was considered statistically significant. SPSS Statistics version 22.0 (IBM, Armonk, NY) was used for all analyses.

Results

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General Characteristics

A total of 206 physicians completed all survey items. Among respondents, 62.6% were male (n=129), with a mean age of 42.8 years (SD=9.6). Specialty distribution (re-tabulated from the source dataset so that categories sum to the full cohort of 206): medical oncology 32.5% (n=67), medical genetics 14.6% (n=30), general/surgical oncology 14.1% (n=29), gynecology/gynecologic oncology 13.6% (n=28), urology 3.4% (n=7), radiation oncology 1.9% (n=4), other 1.0% (n=2), and specialty not specified 18.9% (n=39). Experience: 0–5 years 35.0% (n=72), 6–10 years 19.4% (n=40), 11–15 years 16.0% (n=33), 16–20 years 8.7% (n=18), >20 years 20.9% (n=43). Institution: state university hospital 42.7% (n=88), state/community hospital 24.3% (n=50), private/foundation university 15.5% (n=32), private hospital 13.6% (n=28), private clinic 3.9% (n=8).

The patient/carrier cohort comprised 72 individuals: 93.1% female (n=67), mean age 46.8 years (range 26–74). Cancer diagnoses: breast cancer 61.1% (n=44), ovarian cancer 23.6% (n=17), asymptomatic carrier 12.5% (n=9), other malignancies 2.8% (n=2). Patients under 40 years represented 29.2% of the cohort (n=21).

Physician PGT Awareness: Overall Profile

Overall, 33.0% of physicians (n=68; 95% CI 27.0–39.7%) reported adequate or excellent perceived PGT knowledge, while 22.3% (n=46; 95% CI 17.2–28.5%) reported no knowledge whatsoever. In marked contrast, positive attitudes were substantially higher: 80.1% (n=165; 95% CI 74.1–85.0%) considered PGT medically appropriate, 76.7% (n=158; 95% CI 70.5–82.0%) found it ethically and sociologically acceptable, and 71.8% (n=148; 95% CI 65.3–77.5%) stated they would recommend it to eligible patients (Table 1).

Table 1. Physician-level PGT knowledge and attitude profile (n=206)

PGT Parameter	Positive / Adequate	Negative	No Knowledge / Uncertain
Adequate or Excellent Knowledge	33.0% (n=68)	—	67.0% (n=138)
No Knowledge	22.3% (n=46)	77.7% (n=160)	—
PGT Medically Appropriate	80.1% (n=165)	6.3% (n=13)	13.6% (n=28)
PGT Ethically Acceptable	76.7% (n=158)	8.3% (n=17)	15.0% (n=31)
Would Recommend PGT	71.8% (n=148)	8.7% (n=18)	19.4% (n=40)

Here, "adequate" refers exclusively to self-rated (perceived) knowledge: the knowledge rows summarize physicians' self-assessment (adequate/excellent vs. no knowledge), whereas the appropriateness, ethical-acceptability, and recommendation rows summarize attitudes and are reported separately to avoid conflating the two constructs.

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Specialty-Level Breakdown

Specialty-stratified analysis revealed a striking divergence. Medical genetics (83.3% adequate) and gynecology/gynecologic oncology (67.9% adequate) substantially outperformed other specialties. Critically, when these two groups were excluded, only 16.2% of the remaining 148 physicians — those responsible for managing the majority of BRCA-related cancers in Türkiye — reported adequate PGT knowledge. Medical oncology, the specialty most frequently managing BRCA-positive patients, had the lowest adequate knowledge rate at 7.5%, with 31.3% reporting no knowledge at all. Surgery showed an almost equally concerning profile at 13.8% adequate knowledge and 41.4% with no knowledge (Table 2).

Table 2. PGT knowledge and attitude by physician specialty

Specialty	n	Adequate Perceived Knowledge %	No Knowledge %	Medically Appropriate %	Would Recommend %
Medical Oncology	67	7.5	31.3	85.1	79.1
Medical Genetics	30	83.3	0.0	76.7	63.3
Surgery (General + Oncology)	29	13.8	41.4	72.4	69.0
Gynecology / Gyn. Oncology	28	67.9	0.0	89.3	75.0
Urology	7	14.3	42.9	100.0	100.0
Radiation Oncology	4	25.0	25.0	75.0	75.0
Other	2	0.0	50.0	100.0	50.0
Unspecified (predominantly community)	39	30.8	20.5	71.8	61.5
Excluding Med. Genetics & Gyn. (n=148)	148	16.2	31.1	79.1	75.0

Commented [AB3]: Is there a reason radiation oncology and other are omitted? Not specified.

Experience and Institution Type

Among experience strata, the 16–20 year group showed the highest adequate knowledge (61.1%), possibly reflecting training during the period of PGT's clinical emergence. The lowest adequate knowledge was observed in the 0–5 year group (25.0%) and the >20 year group (34.9%), suggesting that both early-career and late-career physicians remain underserved by PGT-specific education (Table 3). Adequate knowledge by institution type ranged from 17.9% in private hospitals to 62.5% in private clinics, with state university hospitals at 33.0% and state hospitals at 32.0%.

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In an adjusted binary logistic regression (n=206; 68 events), specialty was the dominant determinant of adequate perceived knowledge. Relative to all other specialties combined, training in medical genetics or gynecology/gynecologic oncology was strongly associated with adequate perceived knowledge (odds ratio [OR] 8.06, 95% CI 3.36–19.30, p<0.001), whereas medical oncology was independently associated with markedly lower odds (OR 0.20, 95% CI 0.07–0.60, p=0.004) and surgery showed a comparable, non-significant trend (OR 0.30, 95% CI 0.08–1.08, p=0.066). Greater experience (>10 vs. ≤10 years: OR 1.67, 95% CI 0.52–5.34), private versus public setting (OR 0.85, 95% CI 0.35–2.04), age (OR 1.09 per standard deviation, 95% CI 0.59–2.03), and male sex (OR 0.89, 95% CI 0.41–1.95) were not independently associated with adequate perceived knowledge. A chi-square test confirmed a significant association between specialty and adequate perceived knowledge (χ^2=75.9, df=7, p<0.001); effect size was large (Cramér's V=0.61). Because several specialty cells are small (e.g., urology n=7, radiation oncology n=4), the within-specialty point estimates in Tables 2–3 carry wide and unequal sampling uncertainty and should be interpreted alongside this adjusted model rather than in isolation.

Table 3. PGT knowledge by years of experience and institution

Subgroup	n	Adequate Perceived Knowledge %	No Knowledge %	Medically Appropriate %	Would Recommend %
0–5 years experience	72	25.0	19.4	91.2	83.3
6–10 years	40	40.0	22.5	91.2	90.9
11–15 years	33	24.2	21.2	93.3	93.1
16–20 years	18	61.1	11.1	100.0	87.5
>20 years	43	34.9	32.6	86.1	74.3
State University Hospital	88	33.0	18.2	92.7	86.1
State / Community Hospital	50	32.0	20.0	87.5	83.0
Private / Foundation University	32	40.6	31.2	91.7	85.7
Private Hospital	28	17.9	28.6	92.3	84.6
Private Clinic	8	62.5	25.0	100.0	83.3

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Patient and Carrier PGT Awareness: Overall Profile

Among 72 patients and carriers, 69.4% (n=50) had never been informed about PGT during genetic counseling. Of the 30.6% (n=22) who had received PGT information, only 16.7% (n=12) of the total sample indicated they would consider PGT in the event of a planned pregnancy (Table 4). Because this item is largely inapplicable to older carriers (the cohort mean age was 46.8 years, including a sizeable 50+ stratum), the whole-cohort figure dilutes the estimate; the reproductive-age subgroup (under 40 years), reported below, is therefore the more clinically meaningful denominator for PGT consideration. Pre-test genetic counseling was received by 55.6% (n=40) and post-test by 65.3% (n=47), yet neither rate translated to systematic PGT information provision.

Table 4. PGT information provision and consideration in patient/carrier cohort (n=72)

PGT Parameter	n	%
Informed about PGT during genetic counseling	22	30.6
Not informed about PGT	50	69.4
Would consider PGT for planned pregnancy	12	16.7
Would not consider PGT	60	83.3
Received pre-test genetic counseling	40	55.6
Received post-test genetic counseling	47	65.3

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PGT Awareness by Cancer Diagnosis

Subgroup analysis by cancer diagnosis revealed a critical disparity. Breast cancer patients had the highest PGT information rate (40.9%, 18/44), followed by asymptomatic carriers (33.3%, 3/9). Ovarian cancer patients were by far the least informed, with only 5.9% (1/17) having received PGT information — a finding of particular concern given the direct oncofertility implications of RRSO timing in this group (Table 5).

Table 5. PGT information by cancer diagnosis and age group

Subgroup	n	Informed About PGT %	Would Consider PGT %
Breast cancer	44	40.9	—
Ovarian cancer	17	5.9	—
Asymptomatic carrier	9	33.3	—
Other malignancies	2	0.0	—
Under 40 years	21	42.9	28.6
40 years and above	51	25.5	11.8

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Subgroup	n	Informed About PGT %	Would Consider PGT %
< 35 years	9	44.4	22.2
35–39 years	12	41.7	33.3
40–49 years	23	34.8	8.7
50+ years	28	17.9	14.3

PGT Awareness and Counseling in Patients Under 40 Years

Patients aged under 40 years (n=21) constituted the subgroup with the most clinically urgent reproductive timeline. Within this group, the majority (13/21; 61.9%) had breast cancer or were asymptomatic carriers, with the remainder including one ovarian cancer patient. PGT information was provided to 42.9% of those under 40 (9/21; 95% CI 24.5–63.5%), compared with 25.5% of those aged 40 and above (13/51; 95% CI 15.5–38.9%); this difference was not statistically significant (Fisher's exact p=0.168). More importantly, the consideration rate was numerically higher in the under-40 group (6/21, 28.6% vs. 6/51, 11.8%) but did not differ significantly (Fisher's exact p=0.095), a descriptive association. Given the cross-sectional design, these data cannot establish that information provision drives receptivity; reverse causation (more receptive patients eliciting more counseling) and recall bias cannot be excluded. Among the youngest stratum (under 35 years, n=9), all were carriers or breast cancer patients — the clinically ideal group for PGT — yet only 44.4% had received PGT information and only 22.2% would consider it.

Pre-test genetic counseling was received by only 47.6% (10/21) of those under 40, compared with 58.8% (30/51) in the older group. Post-test counseling rates were 57.1% (12/21) versus 68.6% (35/51), respectively. The impact on future planning was notably greater in the under-40 cohort: 81.0% reported that BRCA test results affected their future plans to some degree (either 'somewhat,' 'affected,' or 'greatly affected'), compared with 62.7% of those aged 40 and above.

Discussion

This study simultaneously assessed PGT-M awareness at physician and patient levels in Türkiye. The central finding is a two-tiered knowledge-action gap: physicians hold strongly favorable attitudes toward PGT yet remain substantially underinformed, and patients receive PGT information far less often than they receive general BRCA counseling — with consequential variation by specialty, diagnosis, and age.

The most clinically significant physician finding is the paradox observed in medical oncology and surgery. Medical oncologists manage the greatest

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volume of BRCA-positive patients in Türkiye yet only 7.5% report adequate perceived knowledge, and 31.3% have none at all. In surgery, these figures are 13.8% and 41.4%, respectively. Both groups, however, view PGT favorably, considering it medically appropriate in the large majority of cases (medical oncology 85.1%, surgery 72.4%) and recommending it for most patients (79.1% and 69.0%, respectively). This is not attitudinal resistance — it is informational absence. Capelouto et al. [12] observed a structurally identical pattern in the United States: while 88% of surveyed physicians agreed patients should receive PGT information, fewer than one in four discussed it. Douma et al. [13] demonstrated in a Dutch multi-specialty study that non-genetics health professionals across multiple specialties consistently lack formal training in hereditary cancer genetics and related reproductive options. These concordant findings confirm that the medical oncologist and surgeon knowledge gap is not unique to Türkiye but represents a structural deficiency in how PGT education is embedded — or absent — in non-genetics specialty training globally.

When medical genetics (83.3% adequate knowledge) and gynecology/gynecologic oncology (67.9%) are removed from the analysis, the inadequacy of the remaining physician population becomes stark: only 16.2% of 148 physicians are adequately informed. This means that in a realistic clinical encounter — in which a BRCA-positive patient is most likely to be managed by an oncologist, surgeon, or gynecologist — the probability of PGT being proactively discussed may be limited, since only a minority of physicians in these specialties reported adequate perceived knowledge. This figure is an indirect inference from self-rated knowledge rather than a directly measured counseling rate and should be interpreted with caution. The observation by Quinn et al. [18] that physicians may be reluctant to raise PGT with patients they perceive as unable to afford it adds an additional layer: financial assumptions compound informational gaps to produce systematic under-referral.

The attitude-knowledge paradox observed in our physician data warrants careful conceptual unpacking. Favorable attitudes are a necessary but insufficient condition for behavioral change. The literature on non-directive genetic counseling is instructive here. Douma al. [13] noted that non-genetics specialists tend to favor a patient-led, non-directive model — which, while ethically appropriate for value-laden decisions, becomes problematic when it extends to withholding information the patient needs to make that decision in the first place. In our data, several physicians who indicated they would not recommend PGT explained this in terms of respecting patient autonomy ('I inform but do not recommend') or uncertainty ('I do not know why'). These responses underscore that the boundary between non-directive counseling and uninformative counseling must be explicitly addressed in education initiatives.

On the patient side, the 69.4% rate of no PGT information is the most direct evidence of the system's failure to translate available technology into clinical

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dialogue. The comparison with published European data is illuminating: Dervin et al. [11] reported 63.2% awareness in a French cohort, and Gietel-Habets et al. [19] reported 66% in a Dutch sample. That the Türkiye figure is nearly 40 percentage points below these benchmarks indicates a systemic rather than marginal gap. Importantly, this gap cannot be attributed to PGT unavailability, as the technology is accessible through specialized reproductive medicine centers in major Turkish cities.

The ovarian cancer subgroup deserves particular attention. Only 5.9% of ovarian cancer patients had received PGT information, compared with 40.9% of breast cancer patients. This disparity likely reflects the clinical reality that ovarian cancer management typically requires urgent and extensive surgical intervention, often followed by systemic therapy, which limits the feasibility and prioritization of reproductive counseling at the time of diagnosis. While this pattern is therefore clinically understandable, it nonetheless represents a genuine care gap rather than an acceptable norm: because RRSO timing makes oncofertility counseling especially consequential in this group, the very low information rate remains a particular concern and an explicit target for improvement.

PGT Counseling in Patients Under 40 Years

The finding that patients under 40 years of age had both higher PGT information rates (42.9% vs. 25.5%) and substantially higher consideration rates (28.6% vs. 11.8%) than older patients is the most actionable observation in the patient cohort. It confirms what reproductive medicine data predict [15]: younger patients, when informed, engage with PGT as a viable reproductive option. The consideration rate of 33.3% in the 35–39 year stratum is particularly noteworthy — this is precisely the group facing the most acute reproductive-surgical timeline pressure in BRCA1 carriers, for whom RRSO is recommended by age 35–40.

Despite this receptivity, even in the under-40 group, 57.1% were not informed about PGT. Pre-test genetic counseling uptake was lower (47.6%) in this group than in older patients (58.8%). This finding runs counter to clinical intuition: one would expect providers to be more attentive to reproductive counseling needs in younger patients. The data suggest instead that PGT counseling is opportunistic — occurring when a provider happens to raise it — rather than systematic. Nahshon et al. [10] reported that mutation detection age was the single strongest predictor of PGT consideration among BRCA carriers; younger patients who received information were more likely to act on it. The convergence of our data with this Israeli cohort strengthens the case for age-specific PGT counseling protocols.

The observation that 81.0% of under-40 patients reported that BRCA testing affected their future planning (vs. 62.7% of those aged 40+) indicates that the reproductive stakes of BRCA positivity are felt acutely by younger individuals. This psychological readiness represents a clinical opportunity: if PGT is raised during the period when patients are actively reconsidering their

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reproductive futures, the probability of meaningful engagement and informed choice is highest. Oncofertility specialists consistently emphasize that oocyte or embryo cryopreservation before age 35 yields the highest live-birth rates in subsequent PGT cycles; [15] any delay in counseling therefore has a measurable clinical cost.

Implications for Clinical Practice

The convergent implications of physician and patient data point toward several structural changes in how PGT is integrated into BRCA clinical pathways in Türkiye. Genetic counseling sessions — whether pre-test or post-test — should consistently include a PGT information component. This cannot remain optional or provider-dependent; it must become a protocol-level standard, with documentation that the discussion occurred.

For medical oncologists and surgeons — who manage the majority of BRCA-positive patients but hold the deepest knowledge deficits — targeted continuing medical education is essential. The content must extend beyond technical knowledge of IVF/PGT-M to encompass patient communication skills, the non-directive/informed boundary, referral pathways, and the critical importance of reproductive timing. Multidisciplinary tumor boards that include reproductive medicine and genetics specialists represent an institutional mechanism for ensuring PGT is raised systematically. [13]

For patients under 40, a specific referral pathway to a reproductive medicine specialist should be established as part of post-BRCA disclosure follow-up — regardless of whether the patient has expressed explicit interest. The data indicate that expressed interest increases substantially when information is provided; therefore, the absence of expressed interest should not be interpreted as absence of need.

At a systemic level, a national oncofertility guideline encompassing BRCA-specific PGT indications, financing, and referral networks is needed. Coverage of PGT-M by the social security system (SGK) for BRCA1/2 carriers would remove the most tangible access barrier and align Türkiye with healthcare systems that have demonstrated cost-effectiveness of this investment.

Limitations

This study has several limitations. Both cohorts were recruited through professional networks and patient advocacy channels; self-selection bias may inflate apparent knowledge and favorable attitudes relative to the broader populations. The patient cohort (n=72) limits statistical inference for subgroup comparisons; findings should be considered hypothesis-generating and confirmed in larger studies. The cross-sectional design precludes causal inference. Patient-level PGT consideration was assessed as intent, not behavior; actual PGT uptake rates are likely lower. Finally, the physician specialty distribution (concentrated in oncology) may not fully represent all BRCA-relevant specialties. In addition, physician knowledge was self-rated

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rather than objectively tested; the reported rates therefore reflect perceived rather than demonstrated competence and are subject to self-report bias, including possible over- or under-estimation. The two questionnaires were investigator-developed and were not formally piloted, and their reliability and validity were not psychometrically established. Several potentially relevant sociodemographic variables (e.g., ethnicity, insurance status, and, for patients, academic versus private care setting) were not collected and could not be examined. Finally, patient BRCA status was self-reported rather than independently confirmed from laboratory records.

Strengths include the dual-perspective design that captures both supply-side (physician) and demand-side (patient) dimensions simultaneously; nationwide geographic representation; parallel analysis by specialty, experience, institution, age, and diagnosis; and the first systematic documentation of PGT awareness in BRCA-positive individuals in Türkiye.

Conclusion

BRCA1/2-positive patients in Türkiye are managed by physicians who hold strongly favorable attitudes toward PGT yet possess insufficient knowledge to translate these attitudes into clinical practice. When medical genetics and gynecology/gynecologic oncology specialists are excluded, the adequate PGT knowledge rate among the remaining physician workforce responsible for BRCA patient management falls to 16.2%. This is not attitudinal resistance; it is structural educational absence — a phenomenon consistently documented by Capelouto et al. [12], Douma et al. [13], and Lombardi et al. [14] across multiple countries and healthcare systems.

On the patient side, 69.4% have never been informed about PGT during genetic counseling. Patients under 40 years, who face the most urgent reproductive timeline and stand to benefit most from early PGT counseling, have somewhat better information rates (42.9%) and substantially higher consideration rates (28.6%) than older patients — confirming that when information is provided, this group is ready to engage. Yet even in the under-40 cohort, a majority remained uninformed, and ovarian cancer patients of all ages represent a critically neglected group (5.9% informed).

Closing this gap requires three parallel actions. Genetic counseling sessions must adopt PGT as a default agenda item rather than an optional one. Medical oncology and surgical training — including both residency curricula and continuing medical education — must incorporate structured oncofertility education. And at the system level, a national BRCA oncofertility framework with clear SGK financing provisions and referral pathways would provide the structural backbone that individual clinical improvements alone cannot supply. The reproductive autonomy of BRCA-positive patients depends on receiving information early enough to act on it; ensuring that every clinician who encounters a BRCA-positive patient under 40 initiates that conversation is the minimum standard the current evidence demands.

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Author Contributions

Irfan Cicin: Substantial contributions to the conception and design of the work; data acquisition; analysis and interpretation of data; drafting and revising the manuscript; final approval and accountability for all aspects of the work.

Tulay Kus, Yesim Eralp, Yüksel Urun, Umut Demirci, Taha Bahsi: Contribution to data acquisition; the design of the study; data interpretation; manuscript revision; final approval.

Mustafa Bozkurt, Mehmet Ali Nahit Sendur, Muhammed Ali Kaplan, Ahmet Bilici, Sema Sezgin Goksu, Hasan Karanlık, Omer Fatih Olmez, Cagatay Arslan, Fatih Kose, Nuri Karadurmus, Cihan Comba, Evren Suer, Zafer Arık, Saadettin Kıckap: Contribution to data acquisition; manuscript revision; final approval.

All authors agree to be accountable for all aspects of the work, ensuring accuracy and integrity.

Conflict of Interest Statement

Irfan Cicin, Tulay Kus, Yesim Eralp, Yüksel Urun, Umut Demirci, Taha Bahsi, Mustafa Bozkurt, Mehmet Ali Nahit Sendur, Muhammed Ali Kaplan, Ahmet Bilici, Sema Sezgin Goksu, Hasan Karanlık, Omer Fatih Olmez, Cagatay Arslan, Fatih Kose, Nuri Karadurmus, Cihan Comba, Evren Suer, Zafer Arık, and Saadettin Kıckap declare that they have no conflict of interest.

Ethical Compliance

This study was reviewed and approved by the Istinye University Ethics Committee (No. 2024/02, 24-56), ensuring compliance with ethical guidelines for human subjects research.

Human Studies and Informed Consent

Informed consent was obtained from all individual participants included in the study. Identifying information has been excluded unless deemed scientifically necessary, with explicit written consent obtained for publication where applicable. This study was conducted using an online survey methodology. Participants were recruited via social media, email, and other online communication channels. Before starting the survey, participants were provided with an information statement outlining the purpose of the research. They were required to indicate their consent to participate by answering an initial question confirming their willingness to proceed. Only those who provided explicit consent were able to access and complete the survey questions.

Data Availability Statement

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Data available on request from the authors: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Funding

This research received no external funding.

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Adjusted binary logistic regression for adequate perceived knowledge among physicians (n=206; 68 events; 7 predictors entered simultaneously). Reference category for specialty = all other specialties combined.

Predictor	**OR**	**95% CI**	**p-value**
Medical genetics or gynecology/gynecologic oncology	8.06	3.36–19.30	<0.001
Medical oncology	0.20	0.07–0.60	0.004
Surgery	0.30	0.08–1.08	0.066
Experience >10 vs. ≤10 years	1.67	0.52–5.34	0.386
Private vs. public setting	0.85	0.35–2.04	0.711
Age (per 1 SD ≈ 9.6 years)	1.09	0.59–2.03	0.779
Male sex	0.89	0.41–1.95	0.776

OR, odds ratio; CI, confidence interval; SD, standard deviation. Estimates derive from a single multivariable model. A chi-square test of the association between specialty and adequate perceived knowledge was significant ($\chi^2 = 75.9$, $df = 7$, $p < 0.001$). Wide confidence intervals for small specialty cells (e.g., urology n = 7, radiation oncology n = 4) reflect limited subgroup size and should be interpreted with caution.

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