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Knowledge and Attitudes Regarding Hematopoietic Stem Cell Donation Awareness Among Voluntary Blood Donors: A Cross-Sectional Study

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Abstract

Background/Objectives: Hematopoietic stem cell transplantation (HSCT) is a life-saving treatment for many hematological disorders, but demand for unrelated donors continues to outpace donor-registry growth. Voluntary blood donors are a strategic population for donor recruitment, yet their HSCT knowledge and attitudes remain understudied. This study examined these and their relationship with sociodemographic characteristics, blood donation behaviors, and each other. Methods: This cross-sectional, descriptive study was conducted with 300 voluntary blood donors aged 18–64 years attending a blood transfusion and apheresis center in Istanbul, Türkiye, between June and October 2025. Face-to-face interviews used a researcher-developed, content-validated Donor Information Form (scale-level content validity index = 0.96; Kuder–Richardson-20 = 0.828 for knowledge and 0.863 for attitude). Data were analyzed using descriptive statistics, *t*-tests, ANOVA, Pearson correlation, and linear regression. Results: Mean knowledge and attitude scores were low (31.85 ± 21.82 and 34.98 ± 26.63 out of 100, respectively). Healthcare professional status, prior HSCT awareness, and previous stem cell donation were each associated with significantly higher knowledge and attitude scores (all $p < 0.001$), with the largest effect observed for previous donation experience on attitude (d = 1.92). Knowledge and attitude were strongly correlated (r = 0.705, $p < 0.001$), and knowledge predicted attitude ($R^2 = 0.496$, $p < 0.001$). Although 29.3% of participants had considered stem cell donation, only 1.7% had ever donated—a gap that also reflects the need to be matched with a recipient. Conclusions: Knowledge and attitudes regarding HSCT among voluntary blood donors were generally insufficient, with a marked gap between donation intention and actual behavior. Knowledge strongly predicted attitude. Nurse-led education at blood donation encounters, combined with simplified donor-registry enrollment, may help expand the pool of registered stem cell donors.

Keywords: attitude; awareness; blood donation; donor; hematopoietic stem cell transplantation; knowledge

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1. Introduction

Blood remains an irreplaceable biological resource that cannot be artificially manufactured, and the safety and sustainability of the blood supply depend largely on voluntary donors [1,2]. The World Health Organization notes that an adequate and reliable supply of safe blood can be assured by a stable base of regular, voluntary, unpaid donors [1], and

donation rates of roughly 1–3% of a country's population are commonly cited as the level needed to meet basic national requirements [2]. Voluntary blood donors are considered a particularly suitable population from which to recruit hematopoietic stem cell donors, given their established, regular contact with the health system, their demonstrated prosocial orientation, and their pre-existing familiarity with donation processes [3]. Understanding this population's knowledge of and attitudes toward hematopoietic stem cell transplantation (HSCT) is therefore an important, but under-studied, step toward closing the persistent gap between the demand for and supply of hematopoietic stem cell donors.

HSCT is one of the most effective, and often curative, treatments available for hematological malignancies, bone marrow failure syndromes, and a range of inherited disorders [4]. The success of HSCT depends heavily on Human Leukocyte Antigen (HLA) compatibility between donor and recipient; because the probability of finding a suitable related donor is only 25–30%, a substantial proportion of patients depend on unrelated volunteer donors [5]. Meeting this need is directly related to the level of public knowledge and awareness of HSCT.

Global data show a marked increase in the incidence of hematological malignancies, reaching an estimated 1,343,850 new cases in 2019 alone [6], while cumulative worldwide activity exceeded 1.5 million procedures by 2019 [7] and the annual number of procedures roughly doubled between 2007 and 2018, when 93,105 (44,425 of them allogeneic) were reported [8]. Expanding and diversifying unrelated donor registries remains an ongoing priority for transplant systems internationally, since demand continues to outpace the growth of registered donor pools [9].

International literature consistently reports low levels of HSCT-related knowledge across diverse populations, even as willingness to donate, when directly asked, tends to considerably outstrip actual knowledge. In a study of voluntary blood donors, only 10.8% demonstrated adequate knowledge of stem cell donation [10], while among health sciences students in Türkiye, 80.8% reported no knowledge of the concept of stem cell donation at all [11]. Insufficient or inaccurate knowledge about hematopoietic stem cell donation, together with fear and anxiety about the donation process, have been identified as key barriers to reaching the number of donors needed, underscoring the importance of targeted education and awareness interventions [12].

A history of blood donation has been shown to be an independent predictor of both favorable attitudes toward hematopoietic stem cell donation and enrollment in donor registries [13], which positions voluntary blood transfusion centers as strategic, accessible points of contact for reaching potential stem cell donors. Nevertheless, comprehensive research specifically targeting this population remains limited, and studies assessing HSCT awareness among voluntary blood donors in Türkiye are scarce. This study therefore aimed to examine the knowledge level and attitudes of voluntary blood donors regarding hematopoietic stem cell transplantation awareness, to determine the relationship of these variables with sociodemographic characteristics and blood donation behaviors, and to identify the association between knowledge and attitude.

2. Materials and Methods

2.1. Study Design

This study used a cross-sectional, descriptive design. The study is reported in accordance with the STROBE guidelines for cross-sectional studies (see Supplementary Materials).

2.2. Setting and Participants

The study was conducted between 9 June and 15 October 2025 at the Blood Transfusion and Apheresis Center of a tertiary-care city hospital in Istanbul, Türkiye. The center has

a 12-chair blood collection capacity and is staffed by 5 physicians, 25 nurses, 4 medical secretaries, and 60 laboratory personnel. The study population comprised 330 individuals who had made a voluntary blood donation at the center within the preceding year. The sample size was calculated using a known-population formula with a 95% confidence level ($\alpha = 0.05$) and a 5% margin of sampling error, yielding a minimum required sample of 178 participants. Data collection continued until 300 eligible, consenting volunteers had been recruited, representing 90.9% of the defined study population. The study population was defined by the donation that qualified each individual for inclusion—that is, a voluntary blood donation made at the center within the preceding year—rather than by a history of donation prior to that visit; accordingly, individuals for whom this qualifying donation was their first-ever blood donation were included in the population but are coded as not having a "previous" donation on the Donor Information Form (Sections 2.3 and 3.2).

Individuals aged 18–64 years who were able to communicate, understand, speak, and read Turkish, who were mentally competent, and who provided written and verbal informed consent were included. Individuals who declined to participate, wished to withdraw during data collection, had a diagnosed mental health disorder, or were unable to communicate were excluded.

2.3. Variables

The dependent variables were the knowledge score and the attitude score regarding hematopoietic stem cell transplantation awareness. The independent variables were participants' sociodemographic characteristics (age, sex, marital status, education, occupation, income level, healthcare professional status) and blood donation/HSCT-related characteristics (previous blood donation, regular donor status, donation frequency, family history of blood disorder, prior HSCT knowledge, family member requiring HSCT, previous stem cell donation, and consideration of stem cell donation).

2.4. Instrument, Validity, and Reliability

Data were collected using a researcher-developed Donor Information Form, constructed from the relevant literature [10,11,14,15]. The form comprised three sections: (a) 17 items on sociodemographic characteristics and blood donation history; (b) a 20-item knowledge questionnaire assessing awareness of HSCT and donation; and (c) a 15-item attitude questionnaire assessing attitudes toward HSCT donation. For both the knowledge and attitude sections, each item was rated as agree, undecided, or disagree; an "agree" response was scored as correct (1 point) and "undecided" or "disagree" responses were scored as incorrect (0 points), with seven attitude items reverse-scored. Section scores were transformed to a 0–100 range.

Content validity was evaluated by five experts in hematology nursing, transplantation nursing, internal medicine nursing, psychiatric nursing, and hematology, using a four-point relevance rating [16]. All items met the recommended item-level content validity index threshold of $\geq$0.80. The scale-level content validity index was 0.96 for both the knowledge and attitude sections, indicating excellent content validity. Internal consistency, evaluated using the Kuder–Richardson-20 coefficient, was 0.828 for the knowledge questionnaire and 0.863 for the attitude questionnaire, indicating good internal consistency for both measures.

2.5. Data Collection

Data were collected by a single researcher through face-to-face interviews with eligible donors at the blood transfusion and apheresis center, using an identical explanation of the study's purpose and a standard assurance of confidentiality for every participant, to minimize interviewer-related variability and encourage candid responses. Participants were informed that their responses would not be used for any purpose other than the

research. Completion of the form took approximately 15–20 min per participant. Each form was reviewed for completeness by the researcher at the point of collection.

2.6. Data Analysis

Data were analyzed using IBM SPSS Statistics 25 and DetaBeeg 1.0. Descriptive statistics were reported as numbers, percentages, means, and standard deviations. The distribution of continuous variables was evaluated using skewness and kurtosis coefficients, both of which fell within the ±2 threshold, supporting the use of parametric tests. Independent-samples *t*-tests were used for two-group comparisons and one-way analysis of variance (ANOVA) with post hoc testing for comparisons involving more than two groups. Pearson correlation analysis was used to examine the relationship between knowledge and attitude scores, and simple linear regression was used to test the predictive effect of knowledge level on attitude. Model fit was evaluated using the F-test and R^2 coefficient, and the Durbin–Watson statistic was used to check for autocorrelation. Statistical significance was accepted at $p < 0.05$. Welch's correction was applied where Levene's test indicated unequal variances, and Bonferroni-adjusted post hoc comparisons followed significant ANOVA results. Effect sizes are reported as Cohen's d, computed with the root mean square of the two group standard deviations, and as η^2 for ANOVA.

2.7. Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki and approved by the Non-Interventional Scientific Research Ethics Committee of İstanbul Atlas University (protocol code 03/29; date of approval: 17 March 2025). Institutional permission was also obtained from the İstanbul Provincial Health Directorate (decision dated 23 May 2025, no. 2025/7). All participants were informed about the purpose of the study, and written and verbal informed consent was obtained prior to data collection.

3. Results

3.1. Characteristics of the Sample

Of the 300 participants, 46.3% were aged 30 years or younger, 82.0% were male, 53.3% were married, and 40.0% held a bachelor's degree. The largest occupational group was private-sector employees (41.3%), and 63.0% reported that their income was equal to their expenses. Healthcare professionals comprised 14.7% of the sample (Table 1).

Table 1. Sociodemographic characteristics of participants (*N* = 300).

Characteristic	Category	*n*	%
Age	≤30 years	139	46.3
	31–40 years	79	26.3
	≥41 years	82	27.3
Sex	Female	54	18.0
	Male	246	82.0
Marital status	Married	160	53.3
	Single	140	46.7
Education	Primary school	34	11.3
	Middle school	41	13.7
	High school	91	30.3
	Bachelor's degree	120	40.0
	Postgraduate	14	4.7

Table 1. *Cont.*

Characteristic	Category	*n*	%
Occupation	Student	19	6.3
	Civil servant	51	17.0
	Private sector	124	41.3
	Retired	15	5.0
	Healthcare worker	18	6.0
	Homemaker	8	2.7
	Manual laborer	34	11.3
	Other	31	10.3
Income level	Less than expenses	61	20.3
	Equal to expenses	189	63.0
	More than expenses	50	16.7
Healthcare professional	Yes	44	14.7
	No	256	85.3

Percentages may not total 100 due to rounding.

3.2. Blood Donation and HSCT-Related Characteristics

Regarding blood donation behavior, 70.7% of participants had donated blood on at least one occasion prior to their qualifying (index) donation, while the remaining 29.3% were donating for the first time at the point of data collection; 42.3% described themselves as regular donors, a separate, self-reported item reflecting a sustained periodic donation pattern rather than prior donation status per se; 3.7% reported a family history of a blood disorder. Only 23.0% of participants reported having any prior knowledge of hematopoietic stem cell transplantation (HSCT) or donation; among those who did, the internet (21.7%) and other healthcare workers (20.3%) were the most frequently cited information sources. While 29.3% of participants said they had considered becoming a hematopoietic stem cell donor, only 1.7% (n = 5) had actually done so. We interpret this gap cautiously: because completing a stem cell donation additionally requires being identified as an HLA-compatible match for a specific patient—a step largely outside the donor's own control—registering as a potential donor, rather than completing an actual donation, would more precisely capture the "action" component of an intention–action gap; registry enrollment was not separately assessed in this study. Among those who had not considered donating, the most common reasons were "I have never thought about it" (49.5%), "I do not know where to apply" (20.3%), and "I am afraid it will harm my health" (17.5%) (Table 2).

Table 2. Blood donation and HSCT-related characteristics of participants (N = 300).

Variable	Category	*n*	%
Previous blood donation	Yes	212	70.7
	No	88	29.3
Regular blood donor	Yes	127	42.3
	No	173	57.7
Family history of blood disorder	Yes	11	3.7
	No	289	96.3
Prior HSCT knowledge/awareness	Yes	69	23.0
	No	231	77.0

Table 2. *Cont.*

Variable	Category	*n*	%
Family member requiring HSCT	Yes	8	2.7
	No	292	97.3
Previously donated stem cells	Yes	5	1.7
	No	295	98.3
Considered stem cell donation	Yes	88	29.3
	No	212	70.7

HSCT = hematopoietic stem cell transplantation.

3.3. Knowledge and Attitude Scores

The mean knowledge score was 31.85 (SD = 21.82, range 0–80), and the mean attitude score was 34.98 (SD = 26.63, range 0–86.67); both distributions fell within acceptable limits of normality (skewness and kurtosis within ±2). Item-level analysis showed that the highest rates of correct responses concerned the life-saving role of HSCT in treating blood disorders (55.7%), trust in authorized health professionals regarding the donation process (55.0%), and the requirement that donors be free of infectious disease (52.3%). The lowest rates of correct responses concerned having personally applied to become a donor (7.7%), the belief that donation is a costly procedure (14.3%), and awareness that the recipient is informed about donor identity before transplantation (14.7%) (Table 3).

Table 3. Items with the highest and lowest correct-response rates on the knowledge and attitude questionnaire (N = 300).

Item	Correct, *n* (%)
Highest agreement	
HSCT is a life-saving treatment for blood disorders	167 (55.7)
I trust only authorized health professionals regarding stem cell donation	165 (55.0)
Stem cell donors must be free of infectious disease (e.g., hepatitis B/C, HIV)	157 (52.3)
Hematopoietic stem cell donation is ethical	151 (50.3)
My rights as a donor will be protected by authorized health professionals	151 (50.3)
Lowest agreement	
I have applied to become a hematopoietic stem cell donor	23 (7.7)
Becoming a stem cell donor is a costly procedure	43 (14.3)
The recipient is informed about donor identity before transplantation	44 (14.7)
I am afraid of possible side effects after donating my stem cells	52 (17.3)
The donor is informed about recipient identity before donation	53 (17.7)

HSCT = hematopoietic stem cell transplantation. "Highest agreement" and "Lowest agreement" rows are section headers, not data rows.

3.4. Comparison of Knowledge and Attitude Scores by Selected Characteristics

Knowledge and attitude scores did not differ significantly by age, sex, income level, regular blood donation status, donation frequency, or family history of blood disorder (all $p > 0.05$). Occupation was significantly associated with both knowledge and attitude scores, although the effect sizes were small; post hoc comparisons indicated that civil servants and healthcare workers scored higher than the "other" occupational group on knowledge, and that civil servants scored higher than the "other" group on attitude. Being a healthcare professional was associated with significantly higher knowledge and attitude scores, with large and moderate effect sizes, respectively. Prior awareness of HSCT was similarly associated with significantly higher knowledge and attitude scores, with moderate effect sizes for both. Having a family member who required HSCT was associated with a significant, very large increase in knowledge scores, but showed no significant association

with attitude scores. The largest effect observed in this study was for previous stem cell donation experience: participants who had previously donated stem cells (n = 5) had markedly and significantly higher attitude scores (M = 72.00, SD = 8.69) than those who had not (M = 34.35, SD = 26.39), with a very large effect size; knowledge scores were also significantly higher in this group, with a moderate effect size. Participants who had considered becoming a stem cell donor scored higher on both knowledge and attitude than those who had not. Among the reasons cited for not considering donation, only fear of harm to one's health was significantly, though weakly, associated with knowledge scores (t = 2.017, p = 0.045, d = 0.18); no other reasons reached statistical significance for either outcome (Table 4).

Table 4. Comparison of knowledge and attitude scores by sociodemographic, blood donation, and HSCT-related characteristics (N = 300).

Variable	Knowledge Score	Attitude Score
Age group	F = 0.041, p = 0.960 (ns)	F = 0.204, p = 0.815 (ns)
Sex	t = −0.206, p = 0.837 (ns)	t = 1.458, p = 0.146 (ns)
Income level	F = 0.089, p = 0.915 (ns)	F = 0.414, p = 0.661 (ns)
Regular blood donation	t = 0.001, p = 1.000 (ns)	t = 0.593, p = 0.554 (ns)
Donation frequency	F = 1.081, p = 0.342 (ns)	F = 0.103, p = 0.902 (ns)
Family history of blood disorder	t = 0.981, p = 0.328 (ns)	t = −0.208, p = 0.835 (ns)
Occupation	F = 2.754, p = 0.009, η^2 = 0.062 *	F = 2.588, p = 0.013, η^2 = 0.058 *
Healthcare professional (yes vs. no)	t = 4.961, p < 0.001, d = 0.80 **	t = 3.807, p < 0.001, d = 0.58 **
Prior HSCT knowledge/awareness (yes vs. no)	t = 4.734, p < 0.001, d = 0.65 **	t = 4.199, p < 0.001, d = 0.58 **
Family member requiring HSCT (yes vs. no)	t = 4.535, p = 0.002, d = 1.11 **	t = 1.713, p = 0.088 (ns)
Previous stem cell donation (yes vs. no)	t = 6.598, p < 0.001, d = 0.60 **	t = 7.511, p < 0.001, d = 1.92 **
Considered stem cell donation (yes vs. no)	Higher among those who had considered it †	Higher among those who had considered it †

HSCT = hematopoietic stem cell transplantation; ns = not significant. * Small effect size; ** moderate-to-very-large effect size. † Exact test statistics for this comparison were not available in the source data.

3.5. Correlation and Regression Analysis

A statistically significant, strong, positive correlation was found between knowledge and attitude scores (r = 0.705, p < 0.001), indicating that attitude scores increased as knowledge scores increased. Simple linear regression confirmed that knowledge level was a significant, positive predictor of attitude, explaining 49.6% of the variance in attitude scores. The Durbin–Watson statistic (2.023) indicated no autocorrelation problem in the model (Table 5).

Table 5. Simple linear regression analysis predicting attitude score from knowledge score (N = 300).

Predictor	B	SE	β	t	p
Constant	7.594	1.936	—	3.923	<0.001
Knowledge score	0.860	0.050	0.705	17.138	<0.001

Model: F(1, 298) = 293.708, p < 0.001; R^2 = 0.496; Adjusted R^2 = 0.495; Durbin–Watson = 2.023. Dependent variable: attitude score.

4. Discussion

This study examined knowledge and attitudes regarding hematopoietic stem cell transplantation (HSCT) awareness among voluntary blood donors and their relationship to sociodemographic and blood-donation characteristics. The predominance of young, male participants is consistent with donor profiles reported internationally [17,18], and the higher proportion of male donors mirrors WHO data showing that women account for only 29% of blood donations worldwide [1], a pattern partly attributable to biological factors such as menstruation, pregnancy, and a higher prevalence of iron deficiency among women donors [19]. An additional, largely structural explanation may lie in national blood donation policy: in Türkiye, regulations permit men to donate whole blood at intervals of 90 days (up to four times per year), whereas women may donate only at

intervals of 120 days (up to three times per year) [20]. Independent of any underlying difference in willingness to donate, this policy difference is likely to make men more frequent visitors to blood donation centers such as the one from which this sample was drawn, and therefore more likely to be captured by a convenience sample recruited from center attendees. This pattern also mirrors the national picture: a 23-year analysis of 9.6 million Türk Kızılay donors (1998–2021) found that 82.0% were men [21], and more recent Türk Kızılay data report 86.8% male donors in 2024 and 84.6% in 2025 [22]. The marked male predominance observed here (82.0%) is therefore consistent with the general Turkish blood-donor population rather than specific to this sample or center. It is more pronounced than in some high-income countries; in the United States, for example, national statistics report an even split or a female majority among blood donors (45.9% male and 54.1% female in 2021; 51% and 49%, respectively, in 2019) [23], suggesting that the size of the gender gap reflects country-specific policy, cultural, and recruitment factors rather than a universal feature of voluntary blood donation. A related but conceptually distinct discrepancy is well documented in stem cell donor registries, where the sex ratio among registrants is reversed. Globally, most registrants are women (57% in 2025, according to the World Marrow Donor Association [WMDA]) [24]; in the DKMS registry, 61.0% of 12.2 million registered donors were women at the end of 2023, whereas men aged 25 years or younger made up only 4.1% of registrants yet had the highest annual donation probability (2.4% for the most favorable profile, 16-fold that of comparable women) [25]. The Italian registry (IBMDR), which recruits donors aged 18–35 years [26], shows the same pattern: roughly 60% of registrants are women [27], whereas about 73% of donations in 2019 came from men [28]. Nearly 60% of registrants are women, although in more than 6 out of 10 cases where a match is found, men are the ones who reach actual donation, for clinical reasons [27]. In the United Kingdom's aligned registry (which includes DKMS UK), men comprised only 39% of new registrants in 2018–2019, but 81% of UK donors who donated to UK patients were male [28]. These patterns reflect transplant centers' preference for younger male donors, and the WMDA has noted that while the global registry grew by 83% over ten years, the number of younger male donors grew by only 23% [29]. This registry-level discrepancy between predominantly female registration and predominantly male donation is distinct from the blood-donation gender imbalance in our sample, but it underlines the practical importance of recruiting male blood donors into the stem cell registry, since it is disproportionately their donations, rather than their registrations, that translate into transplants.

Regarding blood donation behavior, the majority of participants (70.7%) had donated blood previously, considerably higher than the 39.3% reported among hospital employees in Ethiopia [30], which is consistent with recruitment specifically from voluntary blood donors. However, fewer than half (42.3%) were regular donors, indicating that many had donated only sporadically, partly reflecting eligibility criteria and physiological recovery intervals that differ by sex [31]—a pattern also reported among individuals assessed for stem cell donor knowledge and motivation [14]. Only 3.7% reported a family history of a blood disorder, consistent with donation intentions being largely independent of direct family experience of disease [14]. Taken together, these findings suggest that sustaining regular donation, rather than securing an initial one, may be the harder target for donor-retention interventions.

Overall knowledge and attitude scores in this sample were low, consistent with a substantial body of international literature documenting insufficient HSCT-related knowledge even among populations already engaged in blood donation. Comparable findings have been reported among voluntary blood donors in Saudi Arabia, where only 10.8% demonstrated adequate knowledge [10], among health sciences students in Türkiye, 80.8% of whom reported no knowledge of stem cell donation at all [11], and among medical

students, whose mean knowledge score corresponded to roughly half of the maximum possible score [32]. A study conducted in a rural area of Antalya province similarly found limited knowledge of stem cell donation among rural residents (for example, 71.2% believed that the donated product consists entirely of stem cells) [33]. Taken together, these findings suggest that limited HSCT awareness is a global rather than a locally confined phenomenon. Item-level analysis further suggested that participants' knowledge was concentrated around general beliefs—the life-saving role of HSCT and trust in health professionals—rather than procedural details of the donation process, such as anonymity safeguards, donor eligibility, or cost, echoing patterns previously described among health sciences students in Türkiye [12].

Age was not significantly associated with either knowledge or attitude scores in this study, suggesting that awareness of HSCT did not differ meaningfully between younger and older adult donors. A comparable lack of age-related difference has been reported among medical and dental students [34], plausibly reflecting broadly similar access to information sources such as the internet and social media across adult age groups; the relatively narrow, working-age composition of the present sample may also have limited the study's power to detect age-related differences. We consider this null finding further in relation to sample age composition in Sections 4.1 and 4.2, including the potential value of an age-stratified analysis restricted to registry-eligible donors.

Occupation was significantly, though modestly, associated with both knowledge and attitude scores, with civil servants and healthcare workers scoring higher than the residual "other" occupational category on knowledge, and civil servants alone on attitude. Being a healthcare professional showed a considerably stronger and more consistent association: healthcare professionals scored significantly higher than non-healthcare professionals on both knowledge (large effect) and attitude (moderate effect; attitude M = 48.79, SD = 27.00 vs. M = 32.60, SD = 25.88 among non-healthcare professionals). This pattern is consistent with findings among university students, where knowledge of HSCT in Türkiye was found to be insufficient and a training session improved both knowledge and attitudes toward donation [35], and with an experimental study demonstrating that structured educational programs for nursing students produced statistically significant gains in knowledge scores [36]. However, a higher knowledge level among healthcare professionals does not automatically translate into a substantially higher rate of stated willingness to donate: a general-population study in Saudi Arabia found that although healthcare workers were better informed than other occupational groups, only 42.4% expressed willingness to donate [37], and a multicenter study comparing health professionals with the general public similarly noted that donor decision-making is shaped by a wider set of factors—including age, education, gender, ethnicity, and religion—beyond professional knowledge alone [38]. These findings suggest that while professional exposure to clinical information reliably raises knowledge, translating that knowledge into a favorable, action-oriented attitude may require additional, targeted engagement even within the healthcare workforce.

Having prior awareness of HSCT and having a family member who required HSCT were both associated with significantly higher knowledge scores, with the family-experience variable showing a particularly large effect size. This is consistent with the intuitive expectation that direct or indirect exposure to a transplantation need motivates individuals to seek out relevant information; a study of pregnant women in Saudi Arabia similarly found that prior direct or indirect exposure to stem cell therapy was the strongest predictor of willingness to register as a cord blood donor, with women relying on first-hand experience rather than other information sources [39]. Notably, however, family experience of HSCT need did not translate into a significant difference in attitude scores in the present study, in contrast to its very large effect on knowledge. This divergence suggests that knowl-

edge gains driven by personal or family exposure do not automatically or proportionally translate into more favorable attitudes, and that attitude formation is shaped by additional emotional, cultural, and psychosocial factors beyond cognitive awareness—a pattern also reported among newly recruited young potential donors in the United States, where racial and ethnic groups differed in mistrust of stem cell allocation, parental support, religious objections, and knowledge about donation [40].

Previous stem cell donation experience showed by far the largest effect on attitude scores observed in this study, and was also associated with significantly higher knowledge scores. Although this subgroup was very small ($n = 5$) and this finding should be interpreted cautiously, it is compatible with evidence that educational programs can reduce myths and misconceptions about HSCT among medical and nursing students [41]. Prior donors are likely to have passed through pre-donation counseling and medical evaluation, which may explain their more accurate knowledge, while direct experience of the donation process—and, by extension, a stronger sense of having contributed to another person's survival—may explain their markedly more favorable attitudes.

A striking finding of this study was the gap between donation intention and actual donor behavior: while 29.3% of participants had considered becoming a stem cell donor, only 1.7% had ever done so. As noted above, we interpret this gap cautiously, because completing a donation depends not only on the donor's own action but on being identified as a compatible match for a specific patient; donor-registry enrollment, which was not separately measured here, would be a more precise proxy for the "action" component of an intention–action gap than completed donation. Participants who had considered donating scored significantly higher on both knowledge and attitude than those who had not, supporting a positive association between awareness and behavioral intention; a nationwide survey in Italy similarly found that higher knowledge predicted a greater likelihood of donor-registry enrollment [42], a general-population survey in Saudi Arabia found that donation intent was influenced by knowledge [37], a large multinational study of university students across 16 countries reported significantly higher awareness of blood donation among health science students [43], and a systematic review identified knowledge as a facilitator, and lack of knowledge as a barrier, of donation-related behaviors, including joining the donor registry [3]. This intention–action gap is consistent with previous observations that stated willingness to donate stem cells substantially exceeds registered donor numbers (58.8% willing but unregistered versus 3.5% registered in Saudi Arabia) [37], and points to structural and informational barriers [44]—most commonly, in this sample, simply not knowing where to apply—rather than to outright unwillingness. Notably, of the specific reasons given for not considering donation, only fear of harm to one's own health was significantly (though only weakly) associated with knowledge scores; the same systematic review also identified fear of pain and health concerns among the most common barriers to donation [3], which is consistent with this pattern and suggests that the intention–action gap identified here is shaped by a mix of informational, structural, and emotional barriers, most of which may not be resolved by knowledge provision alone. A further, largely unmeasured barrier is the substantially greater personal burden of hematopoietic stem cell donation relative to blood donation: prospective donors must undergo additional testing and clinic visits and, if selected as a match, a considerably more demanding donation procedure than a standard blood draw. A systematic review of unrelated stem cell donation likewise identifies perceived inconvenience, alongside limited knowledge and fear of pain, among the barriers to donation-related behaviors [3]. Because the Donor Information Form used here did not separately assess perceived effort, time cost, or discomfort associated with stem cell donation, we could not formally test this dimension against knowledge and attitude; we return to this point in Section 4.1.

The strong, positive correlation between knowledge and attitude scores, together with the finding that knowledge explained nearly half of the variance in attitude, underscores knowledge as a key, modifiable lever through which attitudes toward hematopoietic stem cell donation might be improved. This finding is consistent with evidence that the cognitive and affective dimensions of stem cell donor behavior tend to move together [34]. At the same time, the divergent pattern observed for family HSCT experience—which strongly predicted knowledge but not attitude—indicates that this relationship is not absolute, and that attitude change cannot be assumed to follow automatically from every source of increased knowledge; educational interventions may therefore need to explicitly target affective and motivational barriers alongside factual content to achieve the largest possible gains in favorable attitudes.

4.1. Strengths and Limitations

This study's principal strength lies in its recruitment of 300 of the 330 eligible voluntary blood donors (90.9%) attending a single, high-volume tertiary blood donation center over a defined period, together with the use of a content-validated and internally consistent measurement instrument. Several limitations should nonetheless be noted. Data were collected at a single center over a limited time frame, which constrains the generalizability of the findings. The sample was restricted to individuals who could understand, speak, and read Turkish, excluding donors from other linguistic backgrounds. Knowledge and attitude measures relied on self-report, introducing the possibility of response bias. The subgroup of participants who had previously donated stem cells was very small (n = 5), limiting the robustness and generalizability of comparisons involving this variable. Some eligible donors declined to complete the questionnaire, which may have introduced non-response bias. The instrument also did not separately assess participants' perceived effort, time cost, or discomfort associated with stem cell donation relative to blood donation, a practical-burden dimension that may partly explain the intention–action gap reported here and that future instruments should incorporate. Because data were collected by a single interviewer through face-to-face interviews, interviewer bias and social desirability bias cannot be excluded, and participants may have given more favorable or socially desirable responses than they would have on an anonymous, self-administered survey. In addition, because eligibility for actual hematopoietic stem cell donor registries is generally restricted to a narrower age range (commonly up to approximately 35–36 years) [26], a substantial proportion of this sample falls outside that range; aggregate, whole-sample estimates therefore incorporate a degree of "background noise" from participants who would not be eligible for registry enrollment regardless of their knowledge or attitude scores, which may dilute the direct applicability of the overall findings to registry recruitment efforts.

4.2. Future Research Directions

Multi-center studies conducted across diverse geographic and demographic groups are recommended to strengthen the generalizability of these findings. Longitudinal and intervention studies are needed to evaluate whether nurse-led educational interventions delivered at blood donation sites can improve not only knowledge and attitude scores but also actual donor-registry enrollment, and whether such interventions need to separately target affective and motivational barriers to close the gap between improved knowledge and improved attitude. Qualitative research exploring the reasons underlying the intention–action gap identified here, including religious and cultural concerns, would usefully complement these quantitative findings. Because the practical relevance of these findings for donor-registry recruitment is greatest among registry-eligible individuals, a dedicated analysis restricted to participants under approximately 36 years of age would help isolate

patterns specific to this target population; given the size of the present sample, we consider this a valuable direction for a subsequent, focused publication rather than the present descriptive report.

4.3. Implications for Practice

Blood transfusion centers represent strategic, readily accessible points of contact for reaching potential hematopoietic stem cell donors. Brief, nurse-led information sessions delivered at the point of blood donation, alongside simplified on-site pathways for national donor-registry enrollment, could help translate donation intention into actual registration. In-service education for nurses and other health professionals should specifically address the knowledge gaps identified here—including donor–recipient anonymity, procedural safety, and the true (low) cost of donation—given the substantial influence of health professional status on knowledge and attitude scores; because knowledge gains do not always translate proportionally into more favorable attitudes, such education should also explicitly address emotional and motivational barriers to donation, not facts alone. Because the internet was participants' leading information source, collaboration between health authorities and national donor registries to disseminate accurate, evidence-based content through digital and social media channels is warranted. Given that a considerable proportion of participants expressed uncertainty about the religious permissibility of stem cell donation, engagement with religious authorities to develop clear, accessible guidance may also help address this barrier.

5. Conclusions

Knowledge and attitudes regarding hematopoietic stem cell transplantation awareness among voluntary blood donors in this study were generally insufficient, despite this population's established engagement with blood donation. Knowledge level emerged as a strong predictor of attitude, and a marked gap was observed between the intention to donate stem cells and completed donation, although registry enrollment itself—arguably a more precise marker of this gap than completed donation—was not directly measured. These findings suggest that brief, nurse-led educational interventions delivered at blood donation centers, integrated with simplified access to national donor registration, could simultaneously improve knowledge and attitudes and help translate donation intention into registered donor status, ultimately expanding the donor pool available to patients awaiting hematopoietic stem cell transplantation.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/hemato7040035/s1. The STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist for cross-sectional studies has been added as Supplementary Material (STROBE_Checklist.docx), with page references keyed to this manuscript [45].

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