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Original article

Factors influencing stem cell donation in post-pandemic Italy among healthcare professionals and the general population: A multicentre study using statistics and generative artificial intelligence

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Abstract. *Background and aim:* The general Italian population's knowledge regarding stem cells is a complex topic, laden with uncertainty and inconsistency. The decision to become a donor can be influenced by factors such as age, education, occupation, sex, ethnicity, and religion. Healthcare professionals' knowledge guides both patients and the practices and techniques they themselves implement. This study aimed to compare the level of knowledge among healthcare professionals and non-healthcare workers regarding hematopoietic stem cell donation in the post-pandemic period. *Methods:* The data used for this study were extracted from the database of a previous published survey that involved healthy adult responders. *Results*: A total of 1,054 individuals participated in the study. Among them, 44.8% (n = 472) were healthcare professionals, and 78.8% (n = 831) reported no prior experience with stem cell transplantation. The study examined differences in knowledge about the bone marrow donor registry between healthcare and non-healthcare participants, revealing that the former demonstrated significantly higher levels of knowledge (over 60%, with R = 64.8–90.2). However, only about 21% of the overall sample reported being registered in the donor registry, with similar proportions observed between the two groups (p = 0.773). The motivations for registration included altruism, access to information, personal experiences, social influence, ethical values, and among healthcare workers, the professional environment. Empathy was found to be significantly more pronounced among healthcare professionals, while satisfaction was higher among non-healthcare participants. A significant number of positive correlations were observed between feelings of solidarity and gratification and other positive emotions, as well as significant negative correlations with items reflecting negative feelings. *Conclusions*: There is no a single aspect that influences stem cell donation but rather multiple elements, from inherent characteristics such as sex to social, religious and personal aspects. Healthcare professionals have more knowledge about stem cell donation, but the feelings and beliefs they express may be similar to those of the general population. (www.actabiomedica.it)

Key words: stem cells, donation, healthcare workers, donor, hematopoietic stem cell transplantation.

Introduction

Hematopoietic stem cell transplantation (HSCT) is a treatment modality that saves the health and lives of a growing number of patients worldwide. In most cases, this procedure is performed to treat haematological malignancies, although it can also be used as therapy for certain non-haemato-oncological diseases (1,2). This treatment can be used for both adult and paediatric patients (3). The advancements in HSCT require the recruitment of an increasing number of unrelated bone marrow donors for allogeneic transplants (3). In 2018, over 30,000 European patients received HSCT. When comparing countries based on the absolute number of transplants and population size, the highest rate was recorded in Germany, with 9.6 transplants per 100,000 inhabitants, followed by Italy (9.4 per 100,000). At the opposite end of the scale were Cyprus (1.2 per 100,000), Romania (1.8 per 100,000) (4). In 2018, 3,379 autologous and 1,908 allogeneic transplants were recorded; in 2019, the number of autologous transplants increased to 3,577 and to 1,943 for allogeneic transplants. Finally, in 2020, a total of 3,434 autologous transplants and 1,911 allogeneic transplants were reported (5). However, the increase in the number of people registering as potential donors is crucial, especially considering that the likelihood of finding a matched donor for any given patient is only 1 in 20,000. This indicates that the vast majority of people who have expressed their willingness to donate bone marrow cells and have undergone sample collection to create their genetic profile will never become actual donors (6). The outbreak of the COVID-19 pandemic led to changes in most aspects of people's daily lives as well as in healthcare systems (7,8). These changes resulted in multiple adjustments in healthcare practices in the field of transplantation, including the reduction of the activity and lower rate of registration as potential bone marrow cell donor (9–11). In many countries, the transplant activity reduction in 2020 also amounted to 5.1% compared to 2019 (12). COVID-19 had a significant impact on the donor pool, leading to changes in previous models through both international and Italian recommendations, aimed at reducing the risk of infection (13–16). During the crisis, international bone marrow donor centres had to cope with a remodulation of international traffic, leading to an increased reliance on national donors (17). Raising public awareness about donation has proven to considerably impact donation rates (18). The Italian general population's knowledge of stem cells (SC) is a complex topic, and research conducted to explore it has highlighted uncertainty and inconsistency. The decision to become a donor can be influenced by factors such as age, education, occupation, sex, ethnicity and religion (19–23). Some studies have also emphasized the importance of an individual's self-perception (24,25). In this context, motivation plays a key role (20). Motivation can be strengthened and stereotypes dispelled by increasing the population's knowledge and awareness of SC and their function as well as of the process and types of donation (26,27). Considering that one of patients' primary sources of information regarding SC is healthcare professionals (HCPs), it is crucial to further investigate their education and training. HCPs' knowledge guides both patients and the practices and techniques they themselves implement. Furthermore, given the increased use of HSCT, it is evident that adequate preparation is essential, as "limited knowledge and negative attitudes are crucial factors in causing professional negligence in healthcare" (28,29). Several studies have focused on analysing medical and nursing preparation on the subject of SC, and some have reported a moderate level of knowledge and awareness (30,31). This underscores the need to enhance education to increase HCPs' knowledge level (32).

Aim

The study aims to highlight differences in knowledge regarding hematopoietic stem cell donation between healthcare and non-healthcare sectors, as well as to explore the factors influencing the decision to donate or not.

Methods

Study design

The data used for this retrospective analysis were extracted from the archives and databases of the AIL

(Associazione Italiana Contro Leucemie, Linfomi e Mieloma) and GITMO (Gruppo Italiano Trapianto di Midollo Osseo) associations. The relationships with these entities were managed by the University of Bari, which agreed to participate in the present study. The extracted information has a national scope: healthy adult volunteer samples (aged over 18) were recruited from regional organizations and foundations focusing on the specific subject under study.

Participants

A convenience sample was used consisting of citizens who participated voluntarily. Recruitment of participants relied on regional organizations that deal with the topic of SC. The sample comprised healthy adults with no physical and/or mental disability from across Italy. In the questionnaire used by the associations, some items inquired whether the respondent had any disability-related issues. Participants who reported having health problems were excluded from the database.

Tools

Data collection aimed at assessing the level of knowledge among the general Italian population regarding peripheral blood stem cell (PBSC) donation and the factors influencing donation was conducted using a non-validated instrument. The questionnaire was developed based on national ministry guidelines and evidence from the scientific literature (33,34). In addition to the dependent variables, several demographic panels were included. The questionnaire was divided into three sections: I – Sociodemographic information; II – Donor registry (comprising 10 yes/no questions); III – Beliefs, feelings, and values, with possible answers ranging from "not at all / slightly / somewhat / very much." Participants were also asked open-ended questions about their reasons for registering or not registering with the donor registry.

Ethical considerations

All sample members were guaranteed anonymity and confidentiality. It was not possible to trace the identity of respondents from the database, as they completed the questionnaire through self-administration by accessing a link.

Data analysis

The collected data were catalogued using an electronic database and analysed with jamovi 2.3.18 statistical software. Descriptive statistical calculations were performed to yield mean, standard deviation, frequencies and percentages. Analyses were conducted using t-tests and ANOVA to identify significant differences, with a 95% confidence interval (CI), while the Chi-square test was used for nominal variables. The internal consistency of the instruments was calculated using Cronbach's alpha, and sample size was measured with the Kaiser–Meyer–Olkin test. For questions with open-ended responses, generative AI (ChatGPT version 4) was employed to cluster similar answers and provide a summary of the results.

Results

Data of a total of 1054 individuals who responded to the questionnaire were collected, of whom 791 (75%) were female and 263 (25%) were male. The sample consisted of 50.3% (n = 530) single individuals and 43.5% (n = 458) married individuals. Regarding employment status, 30.7% (n = 323) were public employees, 24.6% (n = 259) were private employees, 18.1% (n = 191) were students and 11.3% (n = 119) were self-employed professionals. When asked about religious orientation, Christianity was predominant (n = 756; 72.1%), followed by agnostic (n = 258; 24.6%). In the demographic section of the questionnaire, participants were asked if they worked in a healthcare profession. Of the sample, 44.8% (n = 472) worked in healthcare roles. Additionally, 78.8% (n = 831) reported having no experience with HSCT (Table 1).

Dividing the sample into two groups (HCPs and non-HCPs), significant differences were found in nearly all items regarding knowledge and the functioning of the Italian Bone Marrow Donor Registry (IBMDR) (Table 2. HCPs expressed a knowledge level exceeding 60%, with a range (R) of 64.8–90.2.

Table 1. Demographic characteristics of the sample

	N	%
Sex		
Male	263	25.0 %
Female	791	75.0 %
Marital status		
Single	530	50.3 %
Married	458	43.5 %
Separated/Divorced	59	5.6 %
Widowed	7	0.7 %
Employment Status		
Unemployed	40	3.8 %
Student	191	18.1 %
Homemaker	50	4.7 %
Worker	31	2.9 %
Private employee	259	24.6 %
Public employee	323	30.7 %
Self-employed professional	119	11.3 %
Retired	40	3.8 %
Healthcare professional?		
No	581	55.2 %
Yes	472	44.8 %
Religious belief		
Christianity	756	72.1 %
Agnostic	258	24.6 %
Islam	4	0.4 %
Buddhism	11	1.0 %
Other	20	1.9%
Experience of HSCT in a family member/close friend.		
No	831	78.8 %
Yes	224	21.2 %

Agreement percentages below 40% with no statistically significant difference between the two groups were observed for the question "Are you currently registered with the IBMDR?": 21.3% for non-HCPs (n = 124) and 22.1% for HCPs (n = 104) (p=0.773). Similarly, although with statistical significance, the results to the question "Would you be more willing to donate SC if you could choose to whom you donate?" were 36.5% for non-HCPs (n = 212) and 30.6% for HCPs (n = 144) (p = 0.046).

Respondents were also asked to specify the reason for registering or not registering with the IBMDR. Additionally, they were asked about their source of information and where they would like to receive further information. The responses were processed using generative artificial intelligence. Table 3 summarizes the processed results.

Table 4 summarizes the feelings expressed by the sample in response to the question, "What feelings does the thought of donating hematopoietic stem cells evoke in you?" The questionnaire demonstrated good internal consistency (α = 0.822). The feeling of empathy was significantly more prevalent among HCPs (p<0.0001), while satisfaction was more commonly reported by non-HCPs (p=0.018). As expected, HCPs felt less perplexity compared to the other group (p=0.006). Overall, the sample expressed the following feelings with "not at all" or "a little", with percentages > 80%: fear (n = 843) 81.7%, anxiety (n = 842) 82.2%, indifference (n = 936) 96.9%, hesitation (n = 881) 86.5%, apprehension (n = 854) 90.5%, terror (n = 927) 90.5%, fragility (n = 914) 89.5%, worry (n = 863) 84.3%, insecurity (n = 909) 88.9%, vulnerability (n = 904) 88.8%, rejection (n = 984) 96.4%. The combined scores for "somewhat" and "very much" exceeded 80% for the feelings of solidarity (n = 955; 92.3%) and gratification (n = 826; 80.2%).

Table 5 confirms the findings from Table 3, showing a significant number of positive correlations between solidarity and gratification and positive feelings, and significant negative correlations between items expressing non-positive feelings.

Discussion

This study, in accordance with Alzahrani and colleagues, highlighted predictable differences within the sample regarding HCPs' and the general population's knowledge of SC (30). However, even though HCPs were significantly better informed, the percentages describing knowledge levels about the IBMDR ranged from 60% to 95.9%. The lowest value recorded, with 64.4% among HCPs and 48.2% among the general population, was the awareness of the number of patients needing a matched unrelated donor to access

Table 2. Donor Registry knowledge

	Healthcare Personnel		Total	p value
	No	Yes		
	n = 581	n = 472	N = 1053	
	N (%)		N (%)	
Were you aware of the existence of an IBMDR?	487(83.8)	439(93.2)	926(88.0)	<0.0001*
Are you aware that across Italy, there are various institutional functional centres (donor centres mainly located in transfusion services) where you can register as a SC donor?	386(66.4)	398(84.7)	784(74.6)	<0.0001*
Are you aware that hematopoietic stem cell donation is anonymous, voluntary and unpaid?	433(74.7)	424(89.8)	857(81.5)	<0.0001*
Are you aware that SC donation can occur either through bone marrow extraction or from peripheral blood after mobilization with a hematopoietic growth factor?	358(61.6)	392(83.1)	750(71.2)	<0.0001*
Are you aware that in Italy, over 2,000 patients each year need a matched unrelated donor to access the HSCT?	280(48.2)	306(64.8)	586(55.7)	<0.0001*
Are you aware that all mothers can donate the UCB after childbirth?	473(81.4)	425(90.2)	898(85.4)	<0.0001*
Are you aware that in Italy, UCB units donated for altruistic purposes are stored at public banks?	281(48.4)	333(70.6)	614(58.3)	<0.0001*
Are you currently registered to the IBMDR?	124(21.3)	104(22.1)	228(21.7)	0.773
Would you be more willing to donate SC if you could choose to whom you donate?	212(36.5)	144(30.6)	356(33.9)	0.046*

Abbreviations: IBMDR = Italian Bone Marrow Donor registry; SC = Stem Cell; HSCT = Hematopoietic Stem Cell Transplantation; UCB = Umbilical Cord Blood.

* Significant difference.

HSC transplantation. This trend could justify the low percentage (below 23%) in both groups (p = 0.773) in response to the question, "Are you currently registered with the IBMDR?" It is also noteworthy that healthcare professionals and laypeople show similar registration rates in the donor database. The lack of a significant difference between the two groups may be attributed to a shared interest in the information provided by the two associations through social media, as well as the mutual engagement in responding to the questionnaire promoted by the organizations. Another weak significance between the two groups (p = 0.046), with percentages below 40%, was recorded concerning the willingness to donate in relation to the hypothetical possibility of choosing the recipient (Table 3). A significant higher percentage was registered among the general population (36.5%) compared to healthcare workers (30.6%). However, the low propensity to donation and to IBMDR registration highlighted within the sample did not seem to find a correspondence in what felt by the participants thinking to the SC donation, as reported in the section on feelings. Interestingly, only few items resulted significantly different among the groups suggesting that feelings experienced by HCPs are independent by their role and clinical knowledge. The positive feelings shared by both groups (p = 0.05) are encouraging: the items to which more than 60% of participants attributed a score of "somewhat" or "very much" include acceptance (62.4%), solidarity (92.3%), enthusiasm (67.4%) and dignity (78.2%). Negative feelings towards donation were uncommon within the sample. Specifically, significantly low percentages were recorded for the combined scores of "somewhat" and "very much" in items such as fear (18.3%), anxiety (17.9%), indifference (2.9%), grief (3.3%), hesitation (13.4%), apprehension (16.1%), terror (9.5%), fragility (10.5%), worry (15.6%), insecurity (11.1%), vulnerability (11.2%) and rejection (3.6%).

Table 3. Artificial intelligence-generated open-ended responses and results summary

Questions	ChatGPT-found categories:	ChatGPT Summary of Results
If you are currently registered in the hematopoietic stem cell donor registry, or if you have been in the past, could you please indicate the main reason why you registered?	**Main Motivations:** • The desire to do something useful for others was a key motivation. • Being informed or made aware through transfusion services, schools and sector associations significantly influenced the decision to register. • Involvement in similar activities, such as blood donation, was correlated with registering in the stem cell donor registry **Personal Involvement:** • A personal connection with sick friends, relatives, or acquaintances was a significant reason. • Awareness generated by personal experiences and difficult family situations often motivated registration. **Social Influence** • The positive example set by friends, acquaintances, or colleagues was a significant factor. • Social awareness through media, including social media and traditional news outlets, played a role in encouraging participation. **Ethical and Moral Motivations:** • Some responses reflected a sense of moral responsibility and the belief that it is right to be part of the donor list. **Unclear Motivations:** • Some individuals were unable to explain their motivations, possibly suggesting a decision based on impulses or personal beliefs that are not easily verbalized. **Professional Involvement:** • Being involved in the medical field, such as working in a haematology department or being part of a bone marrow transplant unit, influenced some individuals. **Other Considerations:** • Registering to set a good example emerged as a motivation in several cases. • Registration in the donor registry was seen as a convenient opportunity by some participants. **Few Specific Cases:** • Cord blood donation was mentioned as a reason in one case. • Religion (Eastern Protestants) was cited as a reason in one specific case.	This summary provides a detailed analysis of the motivations expressed by participants in the questionnaire regarding registration in the stem cell donor registry. Various motivations clearly emerge, including a strong desire to contribute to the welfare of others, often influenced by personal experiences with sick friends, relatives, or acquaintances. Awareness-raising efforts through transfusion services, schools and sector associations play a significant role in convincing people to register, along with the positive example set by friends, acquaintances, or coworkers. Ethical and moral motivations are also highlighted, with some people believing it is right to be part of the donor list. Some participants attribute their decision to professional experience working in fields related to medicine and bone marrow transplants. However, some responses suggest that motivations can be complex and not always easily explained. Overall, the questionnaire reflects a variety of personal, social and ethical motivations that guide people in choosing to register in the stem cell donor registry.

If you have never been registered as a hematopoietic stem cell donor, could you please indicate the main reason why you have not done so?	**Lack of Awareness:** • Many people stated that they had never thought about stem cell donation or were not sufficiently aware of it. **Health Reasons:** • Some individuals were ineligible due to health issues or had fears related to the effects of donation procedures. **Age Limits:** • Some people reported not registering because they had exceeded the age limit. **Lack of Information:** • Some participants complained about the lack of information on donation centres or said they didn't know how to proceed with registration. **Past Experiences:** • Some individuals expressed a lack of complete trust in the process of managing cells after donation. **Unanswered Online Request:** • One response mentioned having submitted an online registration request without receiving any follow-up contact.	This summary provides a detailed overview of the responses given by participants regarding their non-registration in the stem cell donor registry. Various motivations emerge, outlining a complex network of factors that influence the decision not to participate in this form of donation. First, many individuals seem to be poorly informed or have never seriously considered the possibility of donating stem cells. On the other hand, health-related reasons, such as fear of the effects of donation procedures or existing health issues, play a significant role in influencing this choice. The presence of age limits is another clearly emerging factor, indicating that some potential donors believe they are already outside the acceptable parameters. Practical factors, such as far from donor centre or lack of time, also contribute to hindering registration. Interestingly, a lack of trust in the process and past experiences of receiving bone marrow donations emerge as elements that may impact the willingness to donate. Overall, this analysis provides an in-depth look at the complexity of the motivations behind not registering in the stem cell donor registry.
From which sources have you received information regarding hematopoietic stem cell donation?	**Main Sources:** Internet (mentioned by many people) Healthcare professionals (often cited as sources) Awareness Days (participation in events or awareness campaigns) Non-profit associations Newspapers/magazines and television (used by some, but less frequently) **Common Combinations of Sources:** Internet, healthcare professionals, non-profit associations school, work, awareness days, healthcare professionals, non-profit associations **Direct Participation:** Some people received information directly from healthcare professionals or through participation in awareness days and non-profit associations. **Less Common Sources:** Friends/acquaintances, social media, family members, university lectures, delivery room, antenatal course. **Those Who Were Not Informed:** Some people stated that they had never been informed about hematopoietic stem cell donation.	Analysing the responses to the question regarding sources of information on hematopoietic stem cell donation, several interesting trends emerge. The internet is confirmed as a widespread primary source, cited by numerous participants, reflecting the growing importance of online resources in disseminating medical information. Healthcare professionals are also crucial sources, highlighting the fundamental role of medical personnel in providing accurate and reliable information. Participation in awareness days and involvement with non-profit associations are often combined with other sources, indicating an integrated approach to gathering information. Surprisingly, some people noted that they had never been informed about hematopoietic stem cell donation, highlighting the need for additional efforts in spreading knowledge on this important topic. The diversity of sources, which also includes friends, family and social media, reflects the complexity of the ways people become aware of this issue. Overall, the results indicate the need for diverse and accessible informational strategies to effectively educate the public on hematopoietic stem cell donation.

Table 3 (*Continued*)

Questions	ChatGPT-found categories:		ChatGPT Summary of Results
From which sources would you like to receive further information?	Newspapers/magazines Awareness days Healthcare professionals Non-profit associations Television	Internet Social media School Work Friends/ acquaintances	From the responses, it is evident that the participants prefer to obtain information from a variety of sources. Traditional channels like newspapers and magazines retain significant relevance, highlighting the desire to receive news through more established means. Additionally, the interest shown in awareness days indicates a willingness to actively participate in health information initiatives. Healthcare professionals are considered reliable sources, reflecting trust in medical expertise. Non-profit associations emerge as key players in disseminating information, indicating that people value the more direct and engaging approach of these organizations. Notably, the importance attributed to the internet and social media underscores the growing role of these channels in information transmission. However, it is interesting to note that television, while still holding a relevant place, might be surpassed by more interactive means like the internet and social media, which offer more active user participation. Finally, personal contexts such as work, school and social relationships play a role in shaping information sources. The diversity of preferences underscores the complexity of reaching the public with crucial health information, requiring multiple approaches to meet everyone's needs.

Table 4. Feelings experienced by the participants thinking to SC donation

		HCPs			
		No	Yes	Total	
		n = 581	n = 472	N = 1053	
		n(%)	n(%)	n(%)	p value
Acceptance	Not at all	107(19,2)	76(16,4)	183(17,9)	0,538
	A little	106(19,0)	95(20,5)	201(19,7)	
	Somewhat	194(34,8)	155(33,4)	349(34,1)	
	Very much	151(27,1)	138(29,7)	289(28,3)	
Fear	Not at all	235(41,6)	187(40,1)	422(40,9)	0,497
	A little	223(39,5)	198(42,5)	421(40,8)	
	Somewhat	81(14,3)	67(14,4)	148(14,4)	
	Very much	26(4,6)	14(3,0)	40(3,9)	
Anxiety	Not at all	237(42,1)	183(39,6)	420(41,0)	0,169
	A little	228(40,5)	194(42,0)	422(41,2)	
	Somewhat	69(12,3)	71(15,4)	140(13,7)	
	Very much	29(5,2)	14(3,0)	43(4,2)	
Solidarity	Not at all	9(1,6)	8(1,7)	17(1,6)	0,417
	A little	41(7,2)	22(4,7)	63(6,1)	
	Somewhat	208(36,6)	177(37,9)	385(37,2)	
	Very much	310(54,6)	260(55,7)	570(55,1)	
Indifference	Not at all	500(89,3)	430(92,9)	930(90,9)	0,064
	A little	43(7,7)	21(4,5)	64(6,3)	
	Somewhat	11(2,0)	11(2,4)	22(2,2)	
	Very much	6(1,1)	1(0,2)	7(0,7)	
Enthusiasm	Not at all	53(9,5)	43(9,2)	96(9,4)	0,386
	A little	141(25,2)	97(20,8)	238(23,2)	
	Somewhat	212(37,9)	186(39,9)	398(38,8)	
	Very much	153(27,4)	140(30,0)	293(28,6)	
Gratification	Not at all	31(5,5)	23(4,9)	54(5,2)	0,11
	A little	95(16,8)	55(11,8)	150(14,6)	
	Somewhat	230(40,8)	195(41,8)	425(41,3)	
	Very much	208(36,9)	193(41,4)	401(38,9)	
Grief	Not at all	502(90,1)	406(88,1)	908(89,2)	0,763
	A little	39(7,0)	38(8,2)	77(7,6)	
	Somewhat	12(2,2)	13(2,8)	25(2,5)	
	Very much	4(0,7)	4(0,9)	8(0,8)	
Empathy	Not at all	64(11,5)	17(3,7)	81(7,9)	<0,0001***
	A little	95(17,1)	52(11,2)	147(14,4)	
	Somewhat	195(35,1)	197(42,4)	392(38,4)	
	Very much	202(36,3)	199(42,8)	401(39,3)	

Table 4 (*Continued*)

		HCPs		Total	p value
		No	Yes		
		n = 581	n = 472	N = 1053	
		n(%)	n(%)	n(%)	
Satisfaction	Not at all	25(4,5)	18(3,8)	43(4,2)	0,018*
	A little	103(18,4)	55(11,8)	158(15,4)	
	Somewhat	226(40,4)	194(41,5)	420(40,9)	
	Very much	206(36,8)	201(42,9)	407(39,6)	
Dignity	Not at all	35(6,3)	23(5,0)	58(5,7)	0,151
	A little	96(17,2)	69(14,9)	165(16,2)	
	Somewhat	235(42,2)	181(39,1)	416(40,8)	
	Very much	191(34,3)	190(41,0)	381(37,4)	
Hesitation	Not at all	278(50,1)	217(46,8)	495(48,6)	0,437
	A little	207(37,3)	179(38,6)	386(37,9)	
	Somewhat	51(9,2)	55(11,9)	106(10,4)	
	Very much	19(3,4)	13(2,8)	32(3,1)	
Apprehension	Not at all	242(43,6)	181(39,1)	423(41,6)	0,108
	A little	227(40,9)	204(44,1)	431(42,3)	
	Somewhat	59(10,6)	64(13,8)	123(12,1)	
	Very much	27(4,9)	14(3,0)	41(4,0)	
Terror	Not at all	406(72,5)	324(69,8)	730(71,3)	0,451
	A little	107(19,1)	90(19,4)	197(19,2)	
	Somewhat	36(6,4)	42(9,1)	78(7,6)	
	Very much	11(2,0)	8(1,7)	19(1,9)	
Fragility	Not at all	325(58,1)	264(57,1)	589(57,7)	0,935
	A little	176(31,5)	149(32,3)	325(31,8)	
	Somewhat	50(8,9)	44(9,5)	94(9,2)	
	Very much	8(1,4)	5(1,1)	13(1,3)	
Concern	Not at all	220(39,4)	166(35,8)	386(37,7)	0,665
	A little	252(45,1)	225(48,5)	477(46,6)	
	Somewhat	70(12,5)	60(12,9)	130(12,7)	
	Very much	17(3,0)	13(2,8)	30(2,9)	
Insecurity	Not at all	301(53,8)	256(55,3)	557(54,5)	0,968
	A little	196(35,0)	156(33,7)	352(34,4)	
	Somewhat	49(8,8)	40(8,6)	89(8,7)	
	Very much	14(2,5)	11(2,4)	25(2,4)	
Vulnerability	Not at all	318(57,4)	264(56,9)	582(57,2)	0,944
	A little	177(31,9)	145(31,3)	322(31,6)	
	Somewhat	48(8,7)	45(9,7)	93(9,1)	
	Very much	11(2,0)	10(2,2)	21(2,1)	

		HCPs			
		No	Yes	Total	
		n = 581	n = 472	N = 1053	
		n(%)	n(%)	n(%)	p value
Rejection	Not at all	475(85,3)	390(84,1)	865(84,7)	0,936
	A little	62(11,1)	57(12,3)	119(11,7)	
	Somewhat	17(3,1)	15(3,2)	32(3,1)	
	Very much	3(0,5)	2(0,4)	5(0,5)	
Curiosity	Not at all	131(23,5)	94(20,3)	225(22,0)	0,059
	A little	191(34,2)	134(28,9)	325(31,8)	
	Somewhat	171(30,6)	174(37,6)	345(33,8)	
	Very much	65(11,6)	61(13,2)	126(12,3)	
Exaltation	Not at all	260(46,8)	185(40,0)	445(43,7)	0,109
	A little	135(24,3)	124(26,8)	259(25,4)	
	Somewhat	107(19,2)	111(24,0)	218(21,4)	
	Very much	54(9,7)	42(9,1)	96(9,4)	
Perplexity	Not at all	338(60,8)	297(64,1)	635(62,3)	0,006**
	A little	179(32,2)	119(25,7)	298(29,2)	
	Somewhat	31(5,6)	45(9,7)	76(7,5)	
	Very much	8(1,4)	2(0,4)	10(1,0)	

At under 50%, feelings of curiosity and excitement recorded cautious levels of agreement. Particular attention should be given to gratification, satisfaction and confusion. Regarding the first two, HCPs showed a greater propensity (80.2% and 84.4%, respectively) compared to the general population (77.7% and 77.2%, respectively), while confusion was recorded for 10.1% of HCPs and 7.0% of the general population (p = 0.006). This finding, albeit with low percentages, does not justify the percentage values expressed by HCPs regarding their knowledge. It is perhaps the feelings, beliefs, values and knowledge that have likely contributed to the increase in the number of donors in recent years. Regarding the results based on the demographic characteristics of the sample, lower awareness levels were recorded among women under 25 years of age, with a low level of education or belonging to an ethnic minority background (26). Awareness raising in secondary schools is also crucial but often insufficient, if not entirely absent. In general, several aspects should be considered to understand how the decision to donate can be influenced. Concerning external and social aspects, it is important to examine employment status and religious affiliation (24). It has been shown that social and economic stability coincides with more altruistic attitudes (20). An additional essential distinction to make concerns sex. The study included 263 males (25%) and 791 females (75%). Overall, females seem to be more sensitive to topics of this nature (20). Moreover, motivation and feelings related to donation are essential aspects to consider to have a more precise overall picture. A fundamental aspect that determines knowledge is, in fact, the willingness to become a donor, which can lead individuals to conducting more in-depth research: it has been reported that donors associate more technical and specific words with the topic of HSCT, while non-donors use more general terms (27). Through generative AI, it was also possible to highlight the reasons why participants chose to register in the donor registry or not and their strong desire to be better informed on the subject (35,36). This study reveals a complex network of motivations influencing people's decisions not to register as SC donors. The lack of information and low consideration

Table 5. Spearman's correlation index on feelings

	Acceptance	Fear	Anxiety	Solidarity	Indifference	Enthusiasm	Gratification	Mourning	Empathy	Satisfaction	Dignity	Hesitation	Apprehension	Terror	Fragility	Worry	Insecurity	Vulnerability	Rejection	Curiosity	Exhilaration	Perplexity
Acceptance	1																					
Fear	-,095**	1																				
Anxiety	-,087**	,793**	1																			
Solidarity	,385**	-,072*	--	1																		
Indifference	--	,148**	,128**	-,186**	1																	
Enthusiasm	,330**	-,299**	-,240**	,498**	-,134**	1																
Gratification	,313**	-,121**	-,073*	,597**	-,166**	,673**	1															
Mourning	--	,155**	,157**	-,103**	,256**	--	--	1														
Empathy	,344**	-,103**	--	,559**	-,128**	,458**	,530**	--	1													
Satisfaction	,343**	-,139**	-,090**	,579**	-,175**	,639**	,718**	--	,598**	1												
Dignity	,337**	--	--	,477**	-,127**	,490**	,571**	--	,513**	,681**	1											
Hesitation	--	,575**	,534**	--	,200**	-,248**	-,075*	,177**	--	-,072*	--	1										
Apprehension	-,085**	,734**	,702**	--	,158**	-,274**	-,072*	,179**	--	-,098**	--	,668**	1									
Terror	-,159**	,628**	,597**	-,132**	,185**	-,240**	-,114**	,278**	-,093**	-,109**	-,067*	,537**	,666**	1								
Fragility	-,070*	,482**	,502**	-,084**	,151**	-,224**	-,106**	,303**	--	-,126**	--	,416**	,540**	,531**	1							
Worry	-,065*	,682**	,691**	--	,103**	-,255**	-,091**	,196**	--	-,083**	--	,560**	,738**	,615**	,587**	1						
Insecurity	-,099**	,632**	,631**	-,106**	,209**	-,316**	-,123**	,206**	-,079*	-,135**	--	,591**	,685**	,653**	,611**	,711**	1					
Vulnerability	-,044	,527**	,545**	--	,191**	-,205**	-,085**	,257**	--	-,108**	--	,478**	,604**	,572**	,634**	,643**	,740**	1				
Rejection	-,099**	,401**	,387**	-,210**	,318**	-,185**	-,117**	,332**	-,147**	-,138**	--	,417**	,446**	,575**	,420**	,471**	,564**	,499**	1			
Curiosity	,283**	--	--	,265**	--	,314**	,285**	--	,306**	,304**	,264**	--	,091**	--	--	,070*	--	,107**	--	1		
Exhilaration	,248**	--	--	,243**	--	,433**	,354**	--	,296**	,387**	,318**	--	--	--	--	--	--	--	--	,466**		
Perplexity	-,124**	,502**	,498**	-,188**	,227**	-,270**	-,144**	,231**	-,102**	-,159**	-,072*	,479**	,511**	,532**	,437**	,542**	,581**	,523**	,492**	,078*		

of donation emerged as key factors. Similarly, health-related concerns, such as fear of donation procedures and health issues, played a significant role. Age limits, practical constraints like far from the donor centre, and lack of time also contributed to hindering registration. Additionally, a lack of trust in the process and past experiences with bone marrow donations added further nuances to this complex decision. On the other hand, those who are regularly registered in the IBMDR expressed a strong desire to contribute to the welfare of others, often influenced by personal experiences with sick friends, relatives, or acquaintances. Ethical, moral and professional considerations were also highlighted. The responses also revealed interesting trends regarding sources of information on SC donation. The internet emerged as a primary source, reflecting the growing importance of online resources. Healthcare professionals and non-profit organizations were recognized as reliable sources, underscoring the crucial role of HCPs and organizations dedicated in raising awareness. The diversity of sources, which includes friends, family and social media, highlighted the need for varied informational strategies to effectively educate the public on this critical issue. Finally, traditional channels such as newspapers and magazines remained relevant, but active participation in health information initiatives, such as awareness days, was equally evident. Healthcare professionals and non-profit organizations were seen as key players, emphasizing trust in medical expertise and the engaging approach of health-dedicated organizations. The internet and social media emerged as growing channels, suggesting a preference for interactivity and active user participation. Although the study aimed to use a channel easily accessible to the entire population to achieve generalizable results, it is necessary to consider the limitations that characterize it. The sample size was limited and therefore not representative of the entire population, meaning the results may not apply to all individuals. Additionally, participants may have responded to the questions in a way they believed to be socially acceptable rather than providing their own true opinions, giving answers that may not necessarily align with reality. Another limitation to consider is the topic of the questionnaire; participants may have exaggerated or minimized their experiences, thereby distorting the results.

Conclusions

The results of this study highlight the complexity of the factors influencing knowledge, willingness, and the decision to register as hematopoietic stem cell donors. Although healthcare professionals demonstrated greater informational preparedness compared to the general population, both groups exhibited awareness levels that were not always adequate—particularly concerning the functioning of the Italian Bone Marrow Donor Registry (IBMDR) and the actual need for compatible donors. The low registration rate in the national registry, consistent across both groups, suggests that technical knowledge alone is not sufficient to trigger active donor behavior. On the contrary, emotional factors, ethical values, and personal experiences emerged as central drivers. Positive feelings toward donation—such as solidarity, enthusiasm, dignity, and satisfaction—were predominant, while negative emotions were rarely reported, indicating an emotionally favorable ground for more effective awareness campaigns. Promoting a donation culture grounded in knowledge, but also in trust and empathy, represents a key challenge for the future of stem cell donation in Italy.

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