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Exploring Italians' knowledge of, and perceptions and feelings about stem cell donation: a GITMO-IBMDR nationwide survey

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Background - The current stem cell donor shortage is likely partially due to many individuals' lack of knowledge, beliefs and feelings about the donation process. The aim of this study was to explore these factors to provide the Italian Bone Marrow Donor Registry with information to guide and optimize their awareness campaigns.

Materials and methods - A nationwide anonymous online survey was developed on behalf of the Gruppo Italiano Trapianto di Midollo Osseo and shared on various online platforms. The data were analyzed for frequencies and central tendency values, and geographic areas (Northern, Central and Southern Italy), sex and median age were compared.

Results - The average age of the 1,518 recruited participants was 37.6 (± 13.3) years, and 1,142 (75.2%) were females. Half of the sample (No.=759) was from Southern Italy, 213 (14%) from Central Italy and 546 (36.0%) from Northern Italy. Of the sample, 87.9% knew about The Italian Bone Marrow Donor Registry, and 72.4% were aware that donor centers recruit donors. Respondents from the north, females and older individuals knew significantly more about the stem cell donation process; on a 4-point Likert scale, 55.7% of the sample reported the strongest sense of solidarity, 36.8% felt the most gratification and 39.4% the most satisfaction. Respondents from Southern Italy systematically had significantly higher levels of negative feelings.

Discussion - Our findings identified a specific group of potential donors who systematically correlated with lower awareness about stem cell donation; educational campaigns should target this group.

Keywords: bone marrow transplantation, stem cell donation, cord blood, cell collection, donation awareness.

INTRODUCTION

Allogeneic hematopoietic stem cell transplantation (allo-HSCT) is a life-saving treatment for patients whose immune system is damaged or defective such as those affected by leukaemia, lymphoma, or other onco-hematological diseases. Allo-HSCT involves the administration of a high-dose chemo- and/or radiation-based conditioning regimen

Arrived: 17 December 2024
Revision accepted: 06 May 2025
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followed by the infusion of stem cells (SCs) previously harvested from a healthy donor or collected from cord blood (CB). Over the past half century, allo-HSCT has been used to treat an increasing number of malignant and non-malignant diseases^{1,2}.

Only 25% of the hematology patients needing allo-HSCT find fully matched donors among their siblings, who are considered optimal donors³. Given that finding a suitable donor as rapidly as possible is essential to achieving the best graft outcome, finding donors among compatible unrelated subjects has become a pressing need^{4,5}. However, the high polymorphism of the human leukocyte antigens (HLA), which include the class I-II major histocompatibility complexes (MHC), is not the only factor influencing matched unrelated donor (MUD) availability in the world⁶. While the donor shortage in developed countries may be related to HLA-related factors and/or a lack of knowledge, which decreases the awareness of the importance of donation^{7,8}, social factors such as local ethnicity, culture and economy strongly limit donor availability in various areas worldwide, particularly in the lower income or developing countries⁹⁻¹². In addition to the donor shortage, clinical issues such as patients' need to receive HSCT as soon as possible and the considerable development in treatment options and technologies against graft-versus-host disease (GvHD) have caused an increasing resort to alternatives to family donors such as haploidentical ones¹³.

European patients have the highest probability of finding fully compatible donors thanks to haplotype-related factors as well as to the activity of the various national registry networks^{6,14}. However, the immunogenic consequences on HLA diversity due to the on-going social changes such as immigration from non-European countries and falling fertility rates as well as the differing awareness of SCs from healthy donors, and CB donation among peoples and territories are increasingly challenging topics for donor selection and availability¹⁵⁻¹⁸. In Italy, a high HLA phenotype variety has been detected, creating even greater difficulties in finding fully compatible donors than is the case in other European areas¹⁹. In addition, an increasing genetic heterogeneity has been found moving from the Northern towards the Southern regions²⁰.

The Italian Bone Marrow Donor Registry (IBMDR) is responsible for recruiting donors and collecting their

HLA genotype data. It cooperates with local and national health facilities, and many other registries worldwide affiliated to the World Marrow Donor Association (WMDA)⁹. IBMDR aims to provide patients awaiting allo-HSCT a potential healthy unrelated donor or a CB unit with HLA characteristics so as to give HSCT the highest probability of success²¹. In 2011, the IBMDR decided to optimize its recruitment strategy by enrolling only high-resolution fully typed (HLA-A, -B, -C and DRB1 *loci*) donors under 36 years of age; on a theoretical basis, this should have increased the quality of available donors and the likelihood of IBMDR donor selection¹⁹. On a theoretical basis, given the actual IBMDR size (500,000 potential donors)²², and the high HLA polymorphism in the Italian population²³, more than 30% of Italian patients should find a fully matched (8/8) IBMDR donor, and the probability of finding a 7/8 HLA-matched one should be more than 70%¹⁹. However, of the 1,023 first donation allo-HSCTs performed during 2023 in Italy, only 241 (24%) patients received SCs provided by IBMDR donors, indicating that many other factors affect IBMDR's self-sufficiency and sustainability²². As reported by other authors, the costs of the donation process management are fully covered by the Italian National Health Service, but without providing clinicians with algorithms for registries consultation and donor choice. This certainly penalizes the choice from the Italian registry of older donors and those who had low-resolution typing as well as donors who are not completely compatible (7/8)^{19,22,24}.

In addition to the above considerations, the need for continuous optimization of both the size and HLA variety of IBMDR has led to the implementation of targeted strategies for voluntary donor recruitment²⁵. However, the decision to become a donor seems influenced by many demographic, psychosocial and emotional factors such as age, gender, education and knowledge level, social role and awareness, ethnicity and religion^{7,26}. Furthermore, despite the fact that the widely used donation methods such as CB and peripheral blood stem cell (PBSC) collections are considered safe and low-invasive procedures, donor availability may be affected by misconceptions, beliefs and fears of donation process^{27,28}.

The aim of this study was to increase our understanding of the factors influencing SC donation in Italy through a detailed exploration of variables such as the general

population's knowledge, beliefs, attitudes and feelings about donation and to identify any relationships with sex, age and the participants' area of residence.

MATERIALS AND METHODS

An online nationwide cross-sectional study was designed to survey the knowledge, beliefs, opinions, values, feelings and educational needs of the general population regarding SC donation. The survey was proposed under the auspices of the *Gruppo Italiano Trapianto di Midollo Osseo* (GITMO) [Italian Bone Marrow Transplant Group] and shared online from July 2022 to July 2023. The survey was prepared on the Google Forms® platform (Google, Mountain View, CA, USA), and the link to access the survey was shared through the GITMO network contacts, the *Associazione Italiana Leucemie* (AIL) [Italian Leukemia Association] contacts and on social media such as Twitter® (xAI, San Francisco Bay Area, CA, USA) and Facebook® (Meta, Menlo Park, CA, USA). In addition, a snowballing procedure was adopted for participants' recruitment: a cover letter asked them to involve family members and friends as well as to share the link on their social media. The questionnaire was developed by a panel of experts, including members of the GITMO, the IBMDR, the *Centro Nazionale Trapianti* (CNT) [National Transplant Centre], the *Centro Nazionale Sangue* (CNS) [National Blood Centre] and the University of Bari, who consulted the available literature for the best topics in this field. The questionnaire, tested for clarity and readability by 20 participants from different Italian regions, addressed participants aged 16 and over. The aims of the study and information on its ethical management were clearly reported at the beginning of the questionnaire. The survey was completely anonymous, and both the consent to participate and data utilization were considered as acquired after questionnaire completion and submission. The questionnaire was made up of multiple or single response closed-ended questions divided into 9 sections (*Online Supplementary Material Table S1*): 1) Sociodemographics details (10 items); 2) General knowledge of donation process (9 items); 3) Knowledge of SC role and function (18 items); 4) Knowledge of SC collection methods (5 items); 5) Participants' beliefs (5 items); 6) Participants' feelings (22 items); 7) Opinions and values (8 items); 8) Information/Educational needs (4 items); 9) Reasons for enrolling in IBMDR or not

(2 items, not reported here). The study was approved by the Ethic Committee of the University of Bologna (Protocol No. 0026388 dated 02/02/2023). Participants' feelings were identified by the Authors after having selected 22 human feelings from the literature²⁹ and adapting their definitions to be applicable to SC donation.

The statistical analysis was performed using the Matrix Laboratory (MATLAB) analytical toolbox version 2008 (MathWorks, Natick, MA, USA). Data are presented as numbers or percentages for categorical variables; continuous data are expressed as the mean± standard deviation (SD), or median with interquartile range (IQR). The relationship between two parameters was calculated using Chi square test or Fisher's exact test (dichotomous vs dichotomous), Mann-Whitney test (dichotomous vs no normal continuous data), or Spearman rank correlation where the variable distributions were not normal. Where the tests on medians showed a significant difference and the medians were equal, then the mean rank values were described. Finally, all tests with a p-value of <0.05 were considered significant. To have a picture of the differences across the country, the responses were clustered for three geographical macro areas (North, Centre and South/Islands), as recognized by the Eurostat classification. Correlation analyses were also conducted by age and sex, while comparison strategies per professional role (healthcare professionals vs others), and among groups registered or not with the IBMDR were adopted but their findings will be reported in further publications.

RESULTS

We collected 1,518 completed questionnaires: 1,142 (75.2%) from female respondents and 376 (24.8%) from male respondents. Half (759; 50.0%) were from Southern Italy and the islands, 213 (14%) from Central Italy, and 546 (36.0%) from Northern Italy. The respondents had an average of age of 37.6 (±13.3) years, and less than half of the sample was married (618; 40.7%), while the majority was not (799; 52.6%). More than three-quarters of the respondents had high school diploma (583; 38.4%) or academic degree (608; 40.0%), and the majority was employed in the public (464; 30.5%) or private sector (397; 26.2%). Less than half of the respondents were employed as healthcare professionals (747; 49.2%), a considerable part of the whole cohort had experience within relatives or friends who had

HSCT (308; 20.3%), and 1,141 (75.2%) were not ever enrolled in the IBMDR. Most respondents declared they were Christian/Jewish (1,066; 70.2%) or atheist (384; 25.2%). More demographic details are available in **Table I**.

To facilitate the comprehension of following tables, the authors suggest first consulting the questionnaire sessions (*Online Supplementary Content, Table SI*). The respondents' knowledge, beliefs and feelings regarding SC donation are available in **Table II** and **Table III**.

Participants' knowledge and beliefs regarding stem cell donation

General knowledge of donation process

The analysis of the survey responses revealed several important insights into the participants' general knowledge of the donation process. Most of the sample (1,334; 87.9%) was aware of the existence of the IBMDR, with the highest awareness in Northern Italy (NIT), followed by Central (CIT) and Southern Italy (SIT) and islands, ($p < 0.01$). Interestingly, older participants (median age 38.5 years) showed greater awareness than did younger ones (median age 35.0 years), ($p < 0.01$). There was no significant difference in awareness between male and female respondents.

Approximately three-quarters of the respondents (1,126; 74.2%) were aware that donor centers are available throughout Italy, where individuals can register as SC donors. Although at the limit of significance ($p = 0.05$), this knowledge was more prevalent in NIT (425; 77.8%) compared to CIT (154; 72.3%) and SIT (547; 72.1%). Younger participants (median age 35 vs 42.5 years) and females (89.1 vs 84.0%) tended to be more informed than were males ($p < 0.01$ and $p = 0.01$, respectively).

A large proportion of the sample (1,248; 82.2%) understood that unrelated SC donations are anonymous, voluntary and unremunerated. At the same time, 71.8% (1,090) of participants were knowledgeable about the methods of collection, including bone marrow (BM) harvesting and PBSC collection, but significantly more in NIT ($p < 0.01$). People who were aware of these 2 aspects were younger than those who had not (median 34 vs 40 years, $p < 0.01$; 34 vs 41 years, $p < 0.01$, respectively), and females were significantly more informed on SC collection methods compared to males (83.6 vs 77.9%, $p = 0.01$).

Just over half of the respondents (836; 55.1%) knew that more than 2,000 Italian patients annually require a

Table I - Demographic and personal details of the sample

Variables	Sample (1,518) - No. (%)
Age	
Mean (\pm SD)	37.6 (\pm 13.3)
Median (IQR)	36 (26.47)
Sex	
Male	376 (24.8)
Female	1,142 (75.2)
Geographical area	
North	546 (36.0)
Center	213 (14.0)
South/Islands	759 (50.0)
Marital status	
Married	618 (40.7)
Not married	799 (52.6)
Divorced	92 (6.1)
Widow	9 (0.6)
Education level	
None	1 (0.1)
Elementary school	9 (0.6)
Middle school	91 (6.0)
High school	583 (38.4)
Degree	608 (40.0)
Post-degree	226 (14.9)
Employment	
Housewife	57 (3.8)
Private sector employee	397 (26.2)
Public sector employee	464 (30.5)
Unemployed	58 (3.8)
Freelancer/self-employed	149 (9.8)
Retired	63 (4.2)
Student	330 (21.7)
Religious belief	
Agnostic	30 (2.0)
Atheist	384 (25.2)
Buddhism	16 (1.1)
Christianity/Judaism	1,066 (70.2)
Islam	7 (0.5)
Eastern religions*	4 (0.3)
Prefer not to answer	3 (0.2)
Other	8 (0.5)
Healthcare professional	
Yes	747 (49.2)
No	771 (50.8)
IBMDR registration	
Yes	323 (21.3)
No	1,195 (78.7)
Relative or friend who underwent HSCT	
Yes	308 (20.3)
No	1,210 (79.7)

SD: standard deviation; IQR: Interquartile range.

*Eastern religions: Chinese Religions (traditional Chinese, Confucianism, Taoism, etc.), Indian religions (Hinduism, Sikhism, Jainism, etc.), Shintoism, Caodaism.

compatible unrelated donor for HSCT as a life-saving therapy. There were no significant regional differences in this awareness. A large part of the sample (1,282; 84.5%) was aware of the possibility for all mothers to donate CB, with no differences among the macro areas, while a smaller proportion (878; 57.8%) was informed about CB bank procedures after donation.

Only 323 (21.3%) participants would have been more willing to donate if they could choose the recipient, but this thought was significantly more prevalent in NIT participants (178; 32.6%; $p < 0.01$). Furthermore, those who expressed this thought were older than those who did not (median age 37.5 vs 32.0; $p < 0.01$); no significant difference was found by sex. Finally, 482 participants (31.8%) were aware of voluntary associations' activities promoting SC donation, especially SIT respondents (314; 41.4%; $p < 0.01$). Curiously, those who were aware were older than those who were not (median age 38.0 vs 35.0; $p < 0.01$), and were mostly male (36.4%; $p = 0.02$).

Knowledge of stem cell role and function

The participants' knowledge regarding the role and function of SCs varied significantly across different demographic groups. The majority of them (1,055; 69.5%) had correct knowledge about SCs' duplicating and self-renewing capability, with NIT (398; 72.9%) and CIT (152; 71.4%) participants being significantly more informed compared to SIT (505; 66.5%) ($p < 0.04$). Those who provided correct responses were younger than those who did not (median age 34 vs 38; $p < 0.01$) and were mostly female (71.2 vs 64.4%; $p = 0.01$). While few participants knew that SCs are unspecialized (399; 26.3%), they knew more about SCs' self-renewing and differentiation capability to produce different cell types (954; 62.8%). Knowledge levels were higher in CIT (157; 73.7%) compared to NIT (378; 69.2%) and SIT (419; 55.2%) ($p < 0.01$). Younger individuals and females were more likely to provide correct responses to this item ($p < 0.01$ and $p < 0.01$, respectively).

Participants showed varying levels of knowledge about specific SC functions. For instance, two-thirds of participants knew that SCs are responsible for the production of red blood cells, platelets and white blood cells (997, 65.7%; 953, 62.8%; 968, 63.8%, respectively). However, this level of knowledge appeared limited to these functions due to a high percentage of wrong responses to the "false questions" (questions containing misconceptions) in this

section (see **Table II**, items 2.4-2.9). About the knowledge of SC sources, BM, PBSC and CB were identified as SC sources by 1,315 (86.6%), 1,070 (70.5%) and 1318 (86.8%) participants, respectively. SIT respondents provided significantly lower percentages of correct answers than did CIT and NIT on all items regarding SC sources, as they did for all items regarding misconceptions. Furthermore, our findings showed that participants who provided correct answers were significantly younger than those who provided incorrect ones, and female participants were more likely to provide correct responses (see **Table II**, items 2.10-2.18).

Knowledge of stem cell collection methods

About two-thirds of the sample demonstrated knowledge of the 3 SC collection methods: 1,099 (72.4%) participants were aware of BM harvesting by the iliac crest, while 1,025 (67.5%) knew about PBSC collection method and 965 (63.6%) about CB collection. These findings were significantly more frequent in NIT and CIT participants than in SIT ones ($p < 0.01$ BM; $p < 0.01$ PBSC; $p < 0.01$ CB); respondents who provided correct answers were younger than those who did not ($p < 0.01$; $p < 0.01$; $p < 0.01$, respectively) and were mostly females on all 3 items (see **Table II**, items 3.1-3.3).

However, only 616 (40.6%) were aware of the administration of growth factor drugs before PBSC collection, and less than half of the sample (753, 49.6%) correctly understood that anesthesia is required for BM collection, with higher awareness in NIT (309, 56.6%, $p < 0.01$) and among younger ($p < 0.01$) and female respondents ($p < 0.01$).

Participants' beliefs concerning stem cell donation

Participants' beliefs concerning the risks and pain associated with SC donation were generally accurate but varied by region and demographic (see **Table II**, items 4.1-4.5). A large majority (1,335; 87.9%) correctly believed that umbilical CB collection does not cause pain. Similarly, 1,324 (87.2%) participants correctly responded that CB collection poses no risk to the mother or the baby. In both items, lower correct response percentages were provided by males ($p < 0.01$) and SIT ($p < 0.01$).

The belief that PBSC collection does not pose any risk of developing blood diseases was held by 1,217 (80.2%) participants, with higher awareness in NIT ($p < 0.01$) and among females ($p < 0.01$). Regarding BM harvesting, 1,108 (73.0%) respondents correctly reported that BM explant does not carry the risk of paralysis, with significantly

Table II - Participants' knowledge and beliefs concerning stem cell donation by geographical area, age and sex

1.0 General knowledge about donation process										
Items		Geographical areas				Age			Sex	
No.	Answers	Italy (1,518) No. (%)	SIT (759) No. (%)	CIT (213) No. (%)	NIT (546) No. (%)	p-value (test)	Median (Y vs N)	p-value (test)	% (M/Y vs F/Y)	p-value (test)
1.1	No	184 (12.1)	107 (14.1)	32 (15.0)	45 (8.2)	<0.01 (C)	38.5 vs 35	<0.01 (MW)	20.5 vs 20.2	0.92 (C)
	Yes	1,334 (87.9)	652 (85.9)	181 (85.0)	501 (91.8)					
1.2	No	392 (25.8)	212 (27.9)	59 (27.7)	121 (22.2)	0.05 (C)	35 vs 42.5	<0.01 (MW)	84.0 vs 89.1	0.01 (C)
	Yes	1,126 (74.2)	547 (72.1)	154 (72.3)	425 (77.8)					
1.3	No	270 (17.8)	170 (22.4)	29 (13.6)	71 (13.0)	<0.01 (C)	34 vs 40	<0.01 (MW)	72.1 vs 74.9	0.28 (C)
	Yes	1,248 (82.2)	589 (77.6)	184 (86.4)	475 (87.0)					
1.4	No	428 (28.2)	242 (31.9)	61 (28.6)	125 (22.9)	<0.01 (C)	34 vs 41	<0.01 (MW)	77.9 vs 83.6	0.01 (C)
	Yes	1,090 (71.8)	517 (68.1)	152 (71.4)	421 (77.1)					
1.5	No	682 (44.9)	329 (43.3)	104 (48.8)	249 (45.6)	0.34 (C)	33.5 vs 40	<0.01 (MW)	67.6 vs 73.2	0.03 (C)
	Yes	836 (55.1)	430 (56.7)	109 (51.2)	297 (54.4)					
1.6	No	236 (15.5)	129 (17.0)	25 (11.7)	82 (15.0)	0.16 (C)	35 vs 37	0.09 (MW)	48.1 vs 57.4	<0.01 (C)
	Yes	1,282 (84.5)	630 (83.0)	188 (88.3)	464 (85.0)					
1.7	No	640 (42.2)	329 (43.3)	83 (39.0)	228 (41.8)	0.51 (C)	37 vs 28	<0.01 (MW)	80.1 vs 85.9	0.01 (C)
	Yes	878 (57.8)	430 (56.7)	130 (61.0)	318 (58.2)					
1.8	No	1,195 (78.7)	651 (85.8)	176 (82.6)	368 (67.4)	<0.01 (C)	37.5 vs 32	<0.01 (MW)	54.0 vs 59.0	0.09 (C)
	Yes	323 (21.3)	108 (14.2)	37 (17.4)	178 (32.6)					
1.9	No	1,036 (68.2)	445 (58.6)	154 (72.3)	437 (80.0)	<0.01 (C)	38 vs 35	<0.01 (MW)	36.4 vs 30.2	0.02 (C)
	Yes	482 (31.8)	314 (41.4)	59 (27.7)	109 (20.0)					
2.0 Knowledge of stem cells' role and function										
No.	Answers	Italy (1,518) No. (%)	SIT (759) No. (%)	CIT (213) No. (%)	NIT (546) No. (%)	p-value (test)	Median (R vs W)	p-value (test)	% (M/R vs F/R)	p-value (test)
2.1	Wrong	463 (30.5)	254 (33.5)	61 (28.6)	148 (27.1)	<0.04 (C)	34 vs 38	<0.01 (MW)	64.4 vs 71.2	0.01 (C)
	Right	1,055 (69.5)	505 (66.5)	152 (71.4)	398 (72.9)					
2.2	Wrong	1,119 (73.7)	542 (71.4)	157 (73.7)	420 (76.9)	0.08 (C)	38 vs 35	0.06 (MW)	25.5 vs 26.2	0.70 (C)
	Right	399 (26.3)	217 (28.6)	56 (26.3)	126 (23.1)					
2.3	Wrong	564 (37.2)	340 (44.8)	56 (26.3)	168 (30.8)	<0.01 (C)	33 vs 40	<0.01 (MW)	54.3 vs 65.7	<0.01 (C)
	Right	954 (62.8)	419 (55.2)	157 (73.7)	378 (69.2)					
2.4	Wrong	889 (58.6)	472 (62.2)	123 (57.7)	294 (53.8)	0.01 (C)	32 vs 38	<0.01 (MW)	41.5 vs 41.4	0.98 (C)
	Right	629 (41.4)	287 (37.8)	90 (42.3)	252 (46.2)					
2.5	Wrong	1,086 (71.5)	562 (74.0)	145 (68.1)	379 (69.4)	0.09 (C)	33 vs 37	0.03 (MW)	31.6 vs 27.4	0.11 (C)
	Right	432 (28.5)	197 (26.0)	68 (31.9)	167 (30.6)					
2.6	Wrong	521 (34.3)	308 (40.6)	56 (26.3)	157 (28.8)	<0.01 (C)	33 vs 40	<0.01 (MW)	56.9 vs 68.6	<0.01 (C)
	Right	997 (65.7)	451 (59.4)	157 (73.7)	389 (71.2)					
2.7	Wrong	565 (37.2)	322 (42.4)	63 (29.6)	180 (33.0)	<0.01 (C)	33 vs 40	<0.01 (MW)	53.2 vs 65.9	<0.01 (C)
	Right	953 (62.8)	437 (57.6)	150 (70.4)	366 (67.0)					
2.8	Wrong	1,059 (69.8)	551 (72.6)	147 (69.0)	361 (66.1)	<0.05 (C)	32 vs 37	<0.01 (MW)	31.6 vs 29.8	0.49 (C)
	Right	459 (30.2)	208 (27.4)	66 (31.0)	185 (33.9)					
2.9	Wrong	550 (36.2)	327 (43.1)	57 (26.8)	166 (30.4)	<0.01 (C)	33 vs 41	<0.01 (MW)	56.1 vs 66.3	<0.01 (C)
	Right	968 (63.8)	432 (56.9)	156 (73.2)	380 (69.6)					
2.10	Wrong	566 (37.3)	328 (43.2)	72 (33.8)	166 (30.4)	<0.01 (C)	35 vs 37	0.04 (MW)	63.0 vs 62.6	0.88 (C)
	Right	952 (62.7)	431 (56.8)	141 (66.2)	380 (69.6)					
2.11	Wrong	937 (61.7)	492 (64.8)	140 (65.7)	305 (55.9)	<0.01 (C)	35 vs 36	0.59 (MW)	40.4 vs 37.6	0.32 (C)
	Right	581 (38.3)	267 (35.2)	73 (34.3)	241 (44.1)					
2.12	Wrong	203 (13.4)	135 (17.9)	19 (8.9)	49 (9.0)	<0.01 (C)	34 vs 41	<0.01 (MW)	81.4 vs 88.4	<0.01 (C)
	Right	1,315 (86.6)	624 (82.1)	194 (91.1)	497 (91.0)					
2.13	Wrong	899 (59.2)	492 (64.8)	122 (57.3)	285 (52.2)	<0.01 (C)	33 vs 37	<0.01 (MW)	38.8 vs 41.4	0.38 (C)
	Right	619 (40.8)	267 (35.2)	91 (42.7)	261 (47.8)					

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Table II - Participants' knowledge and beliefs concerning stem cell donation by geographical area, age and sex (continued from previous page)

2.0 Knowledge of stem cells' role and function										
Items		Geographical areas				Age			Sex	
No.	Answers	Italy (1,518) No. (%)	SIT (759) No. (%)	CIT (213) No. (%)	NIT (546) No. (%)	p-value (test)	Median (R vs W)	p-value (test)	% (M/R vs F/R)	p-value (test)
2.14	Wrong Right	448 (29.5) 1,070 (70.5)	269 (35.4) 490 (64.6)	43 (20.2) 170 (79.8)	136 (24.9) 410 (75.1)	<0.01 (C)	34 vs 39	<0.01 (MW)	63.6 vs 72.8	<0.01 (C)
2.15	Wrong Right	428 (28.8) 1,090 (71.2)	263 (34.7) 496 (65.3)	50 (23.5) 163 (76.5)	115 (21.1) 431 (78.9)	<0.01 (C)	35 vs 38	0.02 (MW)	66.5 vs 73.6	<0.01 (C)
2.16	Wrong Right	469 (30.9) 1,049 (69.1)	282 (37.2) 477 (62.8)	57 (26.8) 156 (73.2)	130 (23.8) 416 (76.2)	<0.01 (C)	35 vs 37	0.04 (MW)	65.2 vs 70.4	0.06 (C)
2.17	Wrong Right	737 (48.6) 781 (51.4)	416 (54.8) 343 (45.2)	96 (45.1) 117 (54.9)	225 (41.2) 321 (58.8)	<0.01 (C)	35 vs 36	0.30 (MW)	49.5 vs 52.1	0.38 (C)
2.18	Wrong Right	200 (13.2) 1,318 (86.8)	129 (17.0) 630 (83.0)	15 (7.0) 198 (93.0)	56 (10.3) 490 (89.7)	<0.01 (C)	35 vs 38	0.10 (MW)	42.8 vs 51.8	<0.01 (C)
3.0 Knowledge of stem cell collection methods										
No.	Answers	Italy (1,518) No. (%)	SIT (759) No. (%)	CIT (213) No. (%)	NIT (546) No. (%)	p-value (test)	Median (R vs W)	p-value (test)	% (M/R vs F/R)	p-value (test)
3.1	Wrong Right	419 (27.6) 1,099 (72.4)	260 (34.3) 499 (65.7)	46 (21.6) 167 (78.4)	113 (20.7) 433 (79.3)	<0.01 (C)	33 vs 42	<0.01 (MW)	67.0 vs 74.2	<0.01 (C)
3.2	Wrong Right	493 (32.5) 1,025 (67.5)	317 (41.8) 442 (58.2)	50 (23.5) 163 (76.5)	126 (23.1) 420 (76.9)	<0.01 (C)	33 vs 40	<0.01 (MW)	59.6 vs 70.1	<0.01 (C)
3.3	Wrong Right	553 (36.4) 965 (63.6)	321 (42.3) 438 (57.7)	54 (25.4) 159 (74.6)	178 (32.6) 368 (67.4)	<0.01 (C)	33 vs 39	<0.01 (MW)	52.4 vs 67.3	<0.01 (C)
3.4	Wrong Right	902 (59.4) 616 (40.6)	524 (69.0) 235 (31.0)	119 (55.9) 94 (44.1)	259 (47.4) 287 (52.6)	<0.01 (C)	33 vs 38.5	<0.01 (MW)	40.7 vs 40.5	0.96 (C)
3.5	Wrong Right	765 (50.4) 753 (49.6)	414 (54.5) 345 (45.5)	114 (53.2) 99 (46.8)	237 (43.4) 309 (56.6)	<0.01 (C)	33 vs 38	<0.01 (MW)	42.8 vs 51.8	<0.01 (C)
4.0 Participants' beliefs concerning stem cell donation										
No.	Answers	Italy (1,518) No. (%)	SIT (759) No. (%)	CIT (213) No. (%)	NIT (546) No. (%)	p-value (test)	Median (R vs W)	p-value (test)	% (M/R vs F/R)	p-value (test)
4.1	Wrong Right	183 (12.1) 1,335 (87.9)	131 (17.3) 628 (82.7)	15 (7.0) 198 (93.0)	37 (6.8) 509 (93.2)	<0.01 (C)	36 vs 34	0.20 (MW)	80.3 vs 90.5	<0.01 (C)
4.2	Wrong Right	194 (12.8) 1,324 (87.2)	137 (18.1) 622 (81.9)	11 (5.2) 202 (94.8)	46 (8.4) 500 (91.6)	<0.01 (C)	36 vs 34.5	0.10 (MW)	80.6 vs 89.4	<0.01 (C)
4.3	Wrong Right	301 (19.8) 1,217 (80.2)	186 (24.5) 573 (75.5)	33 (15.5) 180 (84.5)	82 (15.0) 464 (85.0)	<0.01 (C)	35 vs 36	0.70 (MW)	73.7 vs 82.4	<0.01 (C)
4.4	Wrong Right	410 (27.0) 1,108 (73.0)	254 (33.5) 505 (66.5)	40 (18.8) 173 (81.2)	116 (21.2) 430 (78.8)	<0.01 (C)	34 vs 34	0.90 (MW)	69.4 vs 74.2	0.07 (C)
4.5	Wrong Right	424 (27.9) 1,094 (72.1)	233 (30.7) 526 (69.3)	49 (23.0) 164 (77.0)	142 (26.0) 404 (74.0)	0.04 (C)	34 vs 34	1.0 (MW)	66.5 vs 73.9	0.01 (C)

SIT: Southern Italy (& Islands); CIT: Central Italy; NIT: Northern Italy; C: Chi square test; MW: Mann-Whitney test. Wrong answer includes the answer "I don't know". Significant differences are reported in bold.

lower percentages in SIT (505, 66.5%, $p < 0.01$) and males ($p < 0.01$). However, the belief that BM explant results in visible scars was less accurately understood, with 1,094 (72.1%) participants who answered correctly, and greater awareness in NIT ($p = 0.04$) and among female participants ($p = 0.01$).

Participants' feelings about stem cell donation

The participants' feelings about SC donation were measured through a 4-point Likert scale (not at all, a bit, moderately, a lot), reflecting significant regional, age and sex differences. Less than two-thirds of the sample felt a moderate (516, 34.0%) to high (418, 27.5%) sense

of acceptance towards SC donation. This feeling was significantly higher in NIT, where 203 (37.2%) participants answered “a lot” for the item “acceptance”, compared to CIT (71, 33.3%) and SIT (144, 19.0%) ($P < 0.01$). No differences were found by sex or age on this item. Conversely, moderate and high levels of “fear” were felt by 207 (13.6%) and 60 (4.0%) participants, respectively. Significantly higher frequencies ($p < 0.01$) of fear were present in SIT (116, 15.3% and 41, 5.4%, respectively) than in CIT (28, 13.1% and 6, 2.8%) and NIT (63, 11.6% and 13, 2.4%). Very similar results were obtained for “anxiety” (see Table III).

Levels of fear and anxiety increasing appeared inversely correlated with age; the highest levels of these feelings were reported by younger groups ($p < 0.01$ and $p < 0.01$, respectively). A higher level of fear was reported by females ($p = 0.01$), and no significant difference by sex was found for “anxiety”.

Solidarity was a dominant feeling among the participants, with 845 (55.7%) feeling the highest Likert level of solidarity (“a lot”) when thinking about SC donation, particularly in NIT (354; 64.8%) and CIT (135; 63.4%) compared to SIT (356; 46.9%) ($p < 0.01$). Enthusiasm followed a similar trend,

Table III - Participants’ feelings, opinion & values and educational needs by geographical areas, age and sex

5.0 Participants’ feelings concerning stem cell donation										
Items		Geographical area					Age		Sex	
No.	Answers	Italy (1,518) No. (%)	SIT (759) No. (%)	CIT (213) No. (%)	NIT (546) No. (%)	p-value (test)	Median (IQR)	p-value (test)	% (M vs F)	p-value (test)
5.1	Not at all	262 (17.3)	131 (17.2)	36 (16.9)	95 (17.4)	<0.01 (C)	38 (29-49)	0.16 (KW)	17.6 vs 17.1	0.59 (C)
	A bit	322 (21.2)	208 (27.4)	36 (16.9)	78 (14.3)		36.5 (25-48)		23.1 vs 20.6	
	Moderately	516 (34.0)	276 (36.4)	70 (32.9)	170 (31.1)		35 (25-45)		31.4 vs 34.9	
	A lot	418 (27.5)	144 (19.0)	71 (33.3)	203 (37.2)		34 (25-47)		27.9 vs 27.4	
5.2	Not at all	595 (39.2)	257 (33.9)	91 (42.7)	247 (45.2)	<0.01 (C)	40 (29.25-50)	<0.01 (KW)	45.7 vs 37.1	0.01 (C)
	A bit	656 (43.2)	345 (45.4)	88 (41.3)	223 (40.8)		34 (25-46)		40.2 vs 44.2	
	Moderately	207 (13.6)	116 (15.3)	28 (13.1)	63 (11.6)		32 (23-42)		10.4 vs 14.7	
	A lot	60 (4.0)	41 (5.4)	6 (2.8)	13 (2.4)		28 (23.5-37.5)		3.7 vs 4.0	
5.3	Not at all	598 (39.4)	255 (35.6)	89 (41.8)	254 (46.5)	<0.01 (C)	40 (29-50)	<0.01 (KW)	44.4 vs 37.7	0.06 (C)
	A bit	655 (43.1)	350 (46.1)	93 (43.7)	212 (38.8)		35 (26-46.75)		41.5 vs 43.7	
	Moderately	201 (13.2)	117 (15.4)	23 (10.8)	61 (11.2)		30 (23-42.25)		11.4 vs 13.8	
	A lot	64 (4.2)	37 (4.9)	8 (3.7)	19 (3.5)		27 (23-35)		2.7 vs 4.7	
5.4	Not at all	23 (1.5)	16 (2.1)	1 (0.5)	6 (1.1)	<0.01 (C)	40 (31.25-61.5)	<0.01 (KW)	1.3 vs 1.6	0.01 (C)
	A bit	94 (6.2)	60 (7.9)	8 (3.8)	26 (4.8)		43.5 (30-54)		9.6 vs 5.1	
	Moderately	556 (36.6)	327 (43.1)	69 (32.4)	160 (29.3)		37 (26-47)		32.7 vs 37.9	
	A lot	845 (55.7)	356 (46.9)	135 (63.4)	354 (64.8)		34 (26-46)		56.4 vs 55.4	
5.5	Not at all	1,378 (90.8)	686 (90.4)	199 (93.4)	493 (90.3)	0.84 (F)	36 (26-47)	0.87 (KW)	86.2 vs 92.3	<0.01 (F)
	A bit	101 (6.7)	54 (7.1)	10 (4.7)	37 (6.8)		35 (25.75-47)		10.6 vs 5.3	
	Moderately	31 (2.0)	15 (2.0)	4 (1.9)	12 (2.2)		34 (23-57.5)		2.9 vs 1.8	
	A lot	8 (0.5)	4 (0.5)	0 (0.0)	4 (0.7)		37 (31-44)		0.3 vs 0.6	
5.6	Not at all	148 (9.7)	84 (11.1)	15 (7.0)	49 (9.0)	<0.01 (C)	36 (26-47)	0.40 (KW)	8.8 vs 10.1	0.48 (C)
	A bit	392 (25.8)	226 (29.8)	585 (27.2)	108 (19.8)		37 (26-48)		28.7 vs 24.8	
	Moderately	584 (38.5)	294 (38.7)	80 (37.6)	210 (38.5)		34 (25-47)		37.8 vs 38.7	
	A lot	394 (26.0)	155 (20.4)	60 (28.2)	179 (32.8)		35 (26-46)		24.7 vs 26.4	
5.7	Not at all	77 (5.1)	44 (5.8)	7 (3.3)	26 (4.8)	<0.01 (C)	44 (31.75-50.5)	<0.01 (KW)	5.6 vs 4.9	0.03 (C)
	A bit	250 (16.5)	144 (19.0)	26 (12.2)	80 (14.7)		38 (27-48)		21.3 vs 14.9	
	Moderately	633 (41.7)	333 (43.9)	86 (40.4)	214 (39.2)		36 (25.75-47)		38.8 vs 42.6	
	A lot	558 (36.8)	238 (31.4)	94 (44.1)	226 (41.4)		33 (25-46)		34.3 vs 37.6	
5.8	Not at all	1,365 (89.9)	682 (89.9)	194 (91.1)	489 (89.6)	0.62 (F)	35 (26-47)	0.40 (KW)	87.0 vs 90.9	0.03 (F)
	A bit	111 (7.3)	53 (7.0)	15 (7.0)	43 (7.9)		37 (24.25-47)		8.7 vs 6.8	
	Moderately	34 (2.2)	21 (2.8)	4 (1.9)	9 (1.6)		45.5 (23-53)		4.0 vs 1.7	
	A lot	8 (0.5)	3 (0.4)	0 (0.0)	5 (0.9)		39 (29.5-52)		0.3 vs 0.6	
5.9	Not at all	102 (6.7)	65 (8.6)	9 (4.2)	28 (5.1)	<0.01 (C)	44 (33-52)	<0.01 (KW)	8.5 vs 6.1	0.01 (C)
	A bit	215 (14.2)	130 (17.1)	17 (8.0)	68 (12.5)		40 (29-50)		17.8 vs 13.0	
	Moderately	599 (39.5)	324 (42.7)	83 (39.0)	192 (35.2)		35 (25-46)		39.4 vs 39.5	
	A lot	602 (39.7)	240 (31.6)	104 (48.8)	258 (47.3)		33 (25-44)		34.3 vs 41.4	

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Table III - Participants' feelings, opinion & values and educational needs by geographical areas, age and sex (continued from previous page)

5.0 Participants' feelings concerning stem cell donation										
Items		Geographical area				Age			Sex	
No.	Answers	Italy (1,518) No. (%)	SIT (759) No. (%)	CIT (213) No. (%)	NIT (546) No. (%)	p-value (test)	Median (IQR)	p-value (test)	% (M vs F)	p-value (test)
5.10	Not at all	59 (3.9)	31 (4.1)	7 (3.3)	21 (3.8)	<0.01 (C)	36 (30-47.75)	<0.01 (KW)	3.7 vs 3.9	0.02 (C)
	A bit	250 (16.5)	144 (19.0)	24 (11.3)	82 (15.0)		38 (27-51)		21.5 vs 14.8	
	Moderately	611 (40.3)	333 (43.9)	78 (36.6)	200 (36.6)		37 (26-47)		37.0 vs 41.3	
	A lot	598 (39.4)	251 (33.1)	104 (48.8)	243 (44.5)		33 (25-46)		37.8 vs 39.9	
5.11	Not at all	86 (5.7)	37 (4.9)	12 (5.6)	37 (6.8)	<0.01 (C)	34 (23-47)	0.65 (KW)	6.4 vs 5.4	0.86 (C)
	A bit	278 (18.3)	169 (22.3)	24 (11.3)	85 (15.6)		36 (26-50)		18.3 vs 18.3	
	Moderately	602 (39.7)	321 (42.3)	83 (39.0)	198 (36.3)		37 (26-46)		38.3 vs 40.1	
	A lot	552 (36.4)	232 (30.6)	94 (44.1)	226 (41.4)		35 (26-47)		37.0 vs 36.2	
5.12	Not at all	697 (45.9)	324 (42.7)	94 (44.1)	279 (51.1)	0.07 (C)	38 (27-48)	<0.01 (KW)	45.0 vs 46.2	0.91 (C)
	A bit	624 (41.1)	326 (43.0)	96 (45.1)	202 (37.0)		35 (25-46)		41.5 vs 41.0	
	Moderately	149 (9.8)	82 (10.8)	16 (7.5)	51 (9.3)		32 (24-45)		10.6 vs 9.6	
	A lot	48 (3.2)	27 (3.6)	7 (3.3)	14 (2.6)		29 (24-44)		2.9 vs 3.2	
5.13	Not at all	589 (38.8)	273 (36.0)	84 (39.4)	232 (42.5)	0.08 (C)	40 (28-50)	<0.01 (KW)	44.1 vs 37.0	0.11 (C)
	A bit	692 (45.6)	354 (46.6)	104 (48.8)	234 (42.9)		34 (25-45)		42.0 vs 46.8	
	Moderately	179 (11.8)	95 (12.5)	19 (8.9)	65 (11.9)		30 (23-40)		10.4 vs 12.3	
	A lot	58 (3.8)	37 (4.9)	6 (2.8)	15 (2.7)		32 (24-45)		3.5 vs 3.9	
5.14	Not at all	1,038 (68.4)	462 (60.9)	165 (77.5)	411 (75.3)	<0.01 (C)	37 (27-48)	<0.01 (KW)	71.0 vs 67.5	0.41 (C)
	A bit	348 (22.9)	216 (28.5)	31 (14.6)	101 (18.5)		33 (24-44.5)		20.2 vs 23.8	
	Moderately	105 (6.9)	65 (8.6)	13 (6.1)	27 (4.9)		24 (25-46)		7.5 vs 6.8	
	A lot	27 (1.8)	16 (2.1)	4 (1.9)	7 (1.3)		25 (22.25-31.75)		1.3 vs 1.9	
5.15	Not at all	838 (55.2)	393 (51.8)	133 (62.4)	312 (57.2)	0.10 (F)	37 (27-49)	<0.01 (KW)	60.1 vs 53.6	0.13 (C)
	A bit	526 (34.7)	289 (38.0)	61 (28.6)	176 (32.2)		35 (26-46)		30.6 vs 36.0	
	Moderately	129 (8.5)	65 (8.6)	17 (8.0)	47 (8.6)		31 (23-45)		8.2 vs 8.6	
	A lot	25 (1.6)	12 (1.6)	2 (1.0)	11 (2.0)		26 (23-34)		1.1 vs 1.8	
5.16	Not at all	556 (36.6)	255 (33.6)	85 (39.9)	216 (39.6)	0.37 (C)	40 (29-50)	<0.01 (KW)	41.0 vs 35.2	0.22 (C)
	A bit	733 (48.3)	383 (50.5)	98 (46.0)	252 (46.2)		35 (25-46)		44.9 vs 49.4	
	Moderately	183 (12.1)	96 (12.6)	23 (10.8)	64 (11.7)		30 (23-41.75)		11.7 vs 12.2	
	A lot	46 (3.0)	25 (3.3)	7 (3.3)	14 (2.6)		30.5 (24-42)		2.4 vs 3.2	
5.17	Not at all	794 (52.3)	360 (47.4)	114 (53.5)	320 (58.6)	<0.01 (C)	38 (28-48)	<0.01 (KW)	53.5 vs 51.9	0.95 (C)
	A bit	555 (36.6)	310 (40.8)	81 (38.0)	164 (30.0)		34 (26-46)		35.6 vs 36.9	
	Moderately	133 (8.8)	67 (8.8)	14 (6.6)	52 (9.5)		31 (23-45)		8.8 vs 8.8	
	A lot	36 (2.4)	22 (2.9)	4 (1.9)	10 (1.8)		30 (24.5-43.5)		2.1 vs 2.4	
5.18	Not at all	858 (56.5)	398 (52.4)	133 (62.4)	327 (59.9)	0.02 (F)	37 (27-49)	<0.01 (KW)	60.4 vs 55.2	0.11 (C)
	A bit	491 (32.3)	278 (36.6)	61 (28.6)	152 (27.8)		35 (26-46)		27.9 vs 33.8	
	Moderately	135 (8.9)	67 (8.8)	14 (6.6)	54 (9.9)		30 (23-44.75)		10.1 vs 8.5	
	A lot	34 (2.2)	16 (2.1)	5 (2.3)	13 (2.4)		30.5 (25-37)		1.6 vs 2.5	
5.19	Not at all	1,284 (84.6)	610 (80.4)	188 (88.3)	486 (89.0)	<0.01 (F)	35 (26-47)	0.70 (KW)	81.9 vs 85.4	0.02 (F)
	A bit	181 (11.9)	116 (15.3)	22 (10.3)	43 (7.9)		36 (24.75-48)		13.0 vs 11.6	
	Moderately	46 (3.0)	29 (3.8)	3 (1.4)	14 (2.6)		42 (27-51)		5.1 vs 2.4	
	A lot	7 (0.5)	4 (0.5)	0 (0.0)	3 (0.5)		31 (24-48.75)		0.0 vs 0.6	
5.20	Not at all	310 (20.4)	173 (22.8)	37 (17.4)	100 (18.3)	<0.01 (C)	44 (33-53)	<0.01 (KW)	22.3 vs 19.8	0.72 (C)
	A bit	489 (32.2)	265 (34.9)	57 (26.8)	167 (30.6)		37 (37-48)		30.6 vs 32.8	
	Moderately	521 (34.3)	242 (31.9)	85 (39.9)	194 (35.5)		32(24-43)		34.3 vs 34.3	
	A lot	198 (13.0)	79 (10.4)	34 (16.0)	85 (15.6)		29.5 (23-41)		12.8 vs 13.1	
5.21	Not at all	653 (43.0)	354 (46.6)	81 (38.0)	218 (39.9)	<0.01 (C)	40 (30-50)	<0.01 (KW)	39.9 vs 44.1	0.24 (C)
	A bit	404 (26.6)	214 (28.2)	44 (20.7)	146 (26.7)		33 (24.5-46)		30.1 vs 25.5	
	Moderately	319 (21.0)	144 (19.0)	63 (29.6)	112 (20.5)		32 (23-43)		21.8 vs 20.7	
	A lot	142 (9.4)	47 (6.2)	25 (11.7)	70 (12.8)		30 (23-41)		8.2 vs 9.7	
5.22	Not at all	924 (60.8)	398 (52.4)	139 (65.3)	387 (70.9)	<0.01 (F)	36 (26-47)	<0.01 (KW)	57.7 vs 61.9	0.33 (F)
	A bit	469 (30.9)	297 (39.1)	51 (23.9)	121 (22.2)		36 (26-48)		32.4 vs 30.4	
	Moderately	106 (7.0)	56 (7.4)	21 (9.9)	29 (5.3)		31 (23-43)		8.0 vs 6.7	
	A lot	19 (1.3)	8 (1.1)	2 (0.9)	9 (1.6)		29 (23-33.5)		1.9 vs 1.0	

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Table III - Participants' feelings, opinion & values and educational needs by geographical areas, age and sex (continued from previous page)

5.0 Participants' feelings concerning stem cell donation										
Items		Geographical area				Age		Sex		
6.0 Opinions and values										
No.	Answers	Italy (1,518) No. (%)	SIT (759) No. (%)	CIT (213) No. (%)	NIT (546) No. (%)	p-value (test)	Median (IQR)	p-value (test)	% (M vs F)	p-value (test)
6.1	Strongly disagree	70 (4.6)	41 (5.4)	5 (2.3)	24 (4.4)	<0.01 (C)	42 (29-50)	<0.01 (KW)	7.5 vs 3.7	<0.01 (C)
	Disagree	71 (4.7)	46 (6.0)	5 (2.3)	20 (3.7)		42 (32.25-50)		4.2 vs 4.8	
	Undecided	66 (4.3)	34 (4.5)	10 (4.7)	22 (4.0)		33.5 (23-47)		4.8 vs 4.2	
	Agree	642 (42.3)	345 (45.5)	97 (45.5)	200 (36.6)		37 (27-48)		32.2 vs 45.6	
	Strongly agree	669 (44.1)	293 (38.6)	96 (45.2)	280 (51.3)		33 (24.75-45)		51.3 vs 41.7	
6.2	Strongly disagree	52 (3.4)	28 (3.7)	3 (1.4)	21 (3.9)	<0.01 (F)	43 (32.5-54)	<0.01 (KW)	5.6 vs 2.7	<0.01 (C)
	Disagree	46 (3.0)	31 (4.1)	2 (0.9)	13 (2.4)		43 (31-54)		3.2 vs 3.0	
	Undecided	22 (1.5)	15 (2.0)	3 (1.4)	4 (0.7)		30.5 (23-48)		3.7 vs 0.7	
	Agree	468 (30.8)	268 (35.3)	66 (31.0)	134 (24.5)		39 (29-50)		31.1 vs 30.7	
	Strongly agree	930 (61.3)	417 (54.9)	139 (65.3)	374 (68.5)		33 (24-45)		56.4 vs 62.9	
6.3	Strongly disagree	57 (3.8)	30 (3.9)	4 (1.9)	23 (4.2)	<0.01 (C)	43 (33-54)	<0.01 (KW)	6.4 vs 2.9	0.01 (C)
	Disagree	55 (3.6)	37 (4.9)	4 (1.9)	14 (2.6)		41 (22.25-51.5)		4.2 vs 3.4	
	Undecided	50 (3.3)	21 (2.8)	6 (2.8)	23 (4.2)		32.5 (25-44)		4.8 vs 2.8	
	Agree	472 (31.1)	272 (35.8)	61 (28.6)	139 (25.5)		37 (28-49)		28.2 vs 32.1	
	Strongly agree	884 (58.2)	399 (52.6)	138 (64.8)	347 (63.5)		34 (24-45.5)		56.4 vs 58.8	
6.4	Strongly disagree	64 (4.2)	30 (4.0)	6 (2.8)	28 (5.1)	0.25 (C)	40.5 (28-54.5)	<0.01 (KW)	6.6 vs 3.4	0.03 (C)
	Disagree	130 (8.6)	65 (8.6)	19 (8.9)	46 (8.4)		36 (24-46)		8.8 vs 8.5	
	Undecided	117 (7.7)	59 (7.8)	15 (7.1)	43 (7.9)		29 (23-40.25)		9.6 vs 7.1	
	Agree	449 (29.6)	246 (32.4)	52 (24.4)	151 (27.7)		35 (26-46.25)		29.0 vs 29.8	
	Strongly agree	758 (49.9)	359 (47.3)	121 (56.8)	278 (50.9)		37 (27-47)		46.0 vs 51.2	
6.5	Strongly disagree	196 (12.9)	96 (12.6)	17 (8.0)	83 (15.2)	0.01 (C)	33 (23.5-46)	<0.01 (KW)	14.1 vs 12.5	0.81 (C)
	Disagree	388 (25.6)	188 (24.8)	71 (33.3)	129 (23.6)		32 (24-43.5)		23.4 vs 26.3	
	Undecided	208 (13.7)	118 (15.6)	27 (12.7)	63 (11.5)		31 (24-41)		14.1 vs 13.6	
	Agree	379 (25.0)	198 (26.1)	50 (23.5)	131 (24.0)		38 (29-49)		24.5 vs 24.8	
	Strongly agree	347 (22.9)	159 (20.9)	48 (22.5)	140 (25.7)		41 (32-50)		22.9 vs 22.8	
6.6	Strongly disagree	63 (4.2)	35 (4.6)	3 (1.4)	25 (4.6)	0.05 (C)	45 (33-55.75)	<0.01 (KW)	6.7 vs 3.3	0.04 (C)
	Disagree	44 (2.9)	25 (3.3)	6 (2.8)	13 (2.4)		42.5 (25-50)		2.1 vs 3.2	
	Undecided	52 (3.4)	28 (3.7)	7 (3.3)	17 (3.1)		33 (23-48.5)		4.0 vs 3.2	
	Agree	345 (22.7)	194 (25.5)	47 (22.1)	104 (19.0)		38 (28-49)		20.7 vs 23.4	
	Strongly agree	1,014 (66.8)	477 (62.9)	150 (70.4)	387 (70.9)		34 (25-46)		76.5 vs 66.9	
6.7	Strongly disagree	346 (22.8)	133 (17.5)	50 (23.5)	163 (29.8)	<0.01 (C)	40 (29-50)	<0.01 (KW)	28.2 vs 21.0	0.05 (C)
	Disagree	245 (16.1)	108 (14.2)	35 (16.4)	102 (18.7)		39 (28-50)		14.6 vs 16.6	
	Undecided	398 (26.2)	209 (27.5)	57 (26.7)	132 (24.2)		34 (24-47)		25.5 vs 26.5	
	Agree	329 (21.7)	202 (26.6)	37 (17.4)	90 (16.5)		35 (26-45)		20.8 vs 22.0	
	Strongly agree	200 (13.2)	107 (14.1)	34 (16.0)	59 (10.8)		31 (23-41)		10.9 vs 13.9	
6.8	Strongly disagree	157 (10.3)	59 (7.8)	16 (7.5)	81 (14.8)	<0.01 (C)	42.5 (34-52)	<0.01 (KW)	11.5 vs 9.9	0.01 (C)
	Disagree	126 (8.3)	67 (8.8)	14 (6.6)	45 (8.3)		42 (32-52)		10.4 vs 7.6	
	Undecided	160 (10.5)	72 (9.5)	24 (11.3)	64 (11.7)		38.5 (29-52)		13.8 vs 9.5	
	Agree	530 (34.9)	285 (37.5)	73 (34.2)	172 (31.5)		34 (24-46)		34.0 vs 35.2	
	Strongly agree	546 (36.0)	276 (36.4)	86 (40.4)	184 (33.7)		32 (24-42)		30.3 vs 37.8	

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Table III - Participants' feelings, opinion & values and educational needs by geographical areas, age and sex (continued from previous page)

7.0 Educational needs										
No.	Answers	Italy (1,518) No. (%)	SIT (759) No. (%)	CIT (213) No. (%)	NIT (546) No. (%)	p-value (test)	Median (IQR)	p-value (test)	% (M vs F)	p-value (test)
7.1	Not at all	301 (19.8)	188 (24.8)	36 (16.9)	77 (14.1)	<0.01 (C)	39 (29-49.25)	<0.01 (KW)	20.5 vs 19.6	0.01 (C)
	A bit	577 (38.0)	299 (39.4)	91 (42.7)	187 (34.2)		36 (26-47)		41.8 vs 36.8	
	Moderately	500 (33.0)	222 (29.2)	72 (33.8)	206 (37.8)		32 (24-44)		26.3 vs 35.1	
	A lot	140 (9.2)	50 (6.6)	14 (6.6)	76 (13.9)		38 (28-49)		11.4 vs 8.5	
7.2	No	222 (14.6)	89 (11.7)	28 (13.1)	105 (19.2)	<0.01 (C)	34 (30-52)	<0.01 (MW)	18.1 vs 13.5	0.03 (C)
	Yes	1,296 (85.4)	670 (88.3)	185 (86.9)	441 (80.8)		43 (25-45)		81.9 vs 86.5	
7.3	No	58 (3.8)	26 (3.4)	4 (1.9)	28 (5.1)	0.03 (C)	41 (30-50)	<0.01 (KW)	5.1 vs 3.4	0.21 (C)
	I don't know	289 (19.1)	140 (18.4)	32 (15.0)	117 (21.4)		38 (27-50)		23.1 vs 17.7	
	Yes	1,171 (77.1)	593 (78.1)	177 (83.1)	401 (73.4)		35 (25-46)		71.8 vs 78.9	
7.4	No	23 (1.5)	14 (1.8)	1 (0.5)	8 (1.5)	0.36 (F)	36 (24.5-46.5)	0.99 (MW)	4.0 vs 0.7	<0.01 (C)
	Yes	1,495 (98.5)	745 (98.2)	212 (99.5)	538 (98.5)		40 (26-47)		96.0 vs 99.3	

SIT: Southern Italy (& Islands); CIT: Central Italy; NIT: Northern Italy; IQR: inter quartile range; C: Chi square test; KW: Kruskal-Wallis test; F: Fisher's test; MW: Mann-Whitney test. Wrong answer includes the answer "I don't know". Significant differences are reported in bold.

with 394 (26.0%) participants feeling a lot of enthusiasm, especially in CIT and NIT compared to SIT ($p < 0.01$). "Indifference" and "grief" were uncommon among the participants and had no significant geographical correlations.

"Moderate" and "a lot" of enthusiasm was felt by 584 (38.5%) and 394 (26.0%) respondents, respectively. Significantly lower frequencies of enthusiasm were seen in SIT ($p < 0.01$), with differences by age or sex. "Gratification" was moderate in 633 (41.7%) and high in 558 (36.8%) participants and was significantly higher in younger groups and in females ($p < 0.01$ and $p = 0.03$, respectively). "Empathy" and "satisfaction" were frequently reported feelings; 602 (39.7%) and 598 (39.4%) recipients felt a lot of empathy and a lot of satisfaction, respectively. SIT had significantly lower frequencies of both feelings ($p < 0.01$ and $p < 0.01$, respectively), and those who experienced higher levels of "empathy" and "satisfaction" were younger ($p < 0.01$ and $p < 0.01$, respectively) and females ($p < 0.01$ and $p = 0.02$).

Many participants experienced a sense of increased dignity; moderate and high levels were felt by 602 (39.7%) and 552 (36.4%), with significantly lower frequencies in SIT ($p < 0.01$), and with no differences by sex or age. Less than half of the sample experienced moderate (521, 34.3%) to high (198, 13.0%) levels of "curiosity" about SC donation; this was significantly lower in SIT (moderate: 242, 31.9%; high: 79, 10.4%), and those who were more curious were significantly younger ($p < 0.01$) than those who were not. "Exaltation" was uncommon among the respondents when

they thought about SC donation; 653 (43.0%) participants did not experience it, significantly more in SIT (354, 46.6%, $p < 0.01$). Also, they were significantly older than those who experienced any degree of exaltation ($p < 0.01$).

Many other feelings were investigated, such as hesitation, apprehension, terror, frailty, concern, uncertainty, vulnerability, rejection, perplexity, but they were experienced by the participants little or not at all. In almost all these items, significant inverse correlations with median age were found, and no differences by sex emerged as major findings (see Table III).

Opinions and values

The participants' opinions and values regarding SC donation were measured through a 5-point Likert scale (strongly disagree, disagree, undecided, agree, strongly agree). The majority of respondents (1,311; 86.4%) was in favour of using SC for research and clinical trials, with the highest support in CIT (90.5%) and NIT (88.0%) compared to SIT (80.4%) ($p < 0.01$). Those who strongly agreed with it were significantly younger (median age 33 years) than those who strongly disagreed (median age 42 years) ($p < 0.01$), and females were more supportive of this use compared to males ($p < 0.01$). Therefore, 468 (30.8%) respondents agreed and 930 (61.3%) strongly agreed that the HSCT is a life-saving therapy, with lower agreement in SIT ($p < 0.01$), older participants ($p < 0.01$) and males ($p < 0.01$).

When considering whether the donation of hematopoietic stem cells is a choice that everyone should consider, 884 (58.2%) participants strongly agreed and 472 (31.1%) agree,

with lower agreement in SIT ($p < 0.01$), older participants ($p < 0.1$) and males ($p = 0.01$).

Interestingly, half of the sample (758, 49.9%) strongly agreed and a third (449, 29.6%) agreed that CB should be collected by default, with stronger agreement found among females ($p = 0.03$).

The hypothetical proposal of IBMDR registration becoming mandatory divided the sample into different positions: 347 (22.9%) participants would strongly agree with it, 379 (25.0%) would agree, 208 (13.7%) would be undecided, 388 (25.6%) would disagree, and 196 (12.9%) would strongly disagree. NIT was significantly more in agreement with the hypothetical proposal ($p < 0.01$), and those who agreed were significantly older than those who disagreed ($p < 0.01$).

Access to information was a widely shared value, with 1,014 (66.8%) participants who strongly agreed and 345 (22.7%) who agreed that the population should have more information about SC donation. This opinion seemed to be less referred by SIT participants, but just above the limit of significance ($p = 0.05$). Despite unclear distribution of the answers, younger and male respondents seemed to have stronger agreement than did females ($p < 0.01$ and $p = 0.04$, respectively).

A significant portion of participants would like to know the recipient's identity; 329 (21.7%) agreed, and 200 (13.2%) strongly agreed with this. The agreement with this condition appeared to be significantly more frequent in SIT ($p < 0.01$) and in younger participants ($p < 0.01$), but the difference was at the limit of non-significance by sex ($p = 0.05$).

Similarly, a large portion of the participants would like to know the recipients' medical condition: 530 (34.9%) agreed and 546 (36.0%) strongly agreed. This was more frequent in CIT and SIT ($p < 0.01$) and in females ($p = 0.01$), and those who agreed with it were significantly younger ($p < 0.01$).

Education needs

The information and education needs regarding SC donation were explored through the last 4 questions of the questionnaire. A considerable number of respondents considered themselves poorly informed (577, 38.0%), and 301 (19.8%) reported knowing nothing about SC donation. SIT participants perceived themselves as being less educated than did NIT participants ($p < 0.01$). Participants who had not received any education on SC donation were significantly older ($p < 0.01$) and were more frequently males ($p < 0.01$).

An overwhelming majority (1,296; 85.4%) expressed a desire to receive more information about donation, especially SIT participants ($p < 0.01$) and females ($p = 0.03$). Furthermore, 1,171 (77.1%) participants indicated they would be interested in participating in educational events on SC donation, and almost the entire sample 1,495 (98.5%) agreed with the proposal of institutions providing information/educational materials to individuals when they become legal adults at 18.

DISCUSSION

Any strategy developed by institutions that aims at increasing SC donor availability cannot neglect a careful analysis of the demographic context, whether in Italy or in other countries. In addition, many other factors impact the decision of whether to become a SC donor, including the organization of the national donor network, the availability of donor centers throughout the country and the population's level of awareness. The above factors have been widely studied^{19-21,23}. However, as SC donation is an "altruistic choice of a living healthy person" designed to benefit unrelated people,²⁶ it is strongly influenced by sociocultural factors that are deeply linked with the local population's identity and by psychoemotional factors that have strong ties to personal experiences, making the latter frequently unpredictable and widely variable³⁰⁻³². One's willingness to become a SC donor can take on important connotations, for example, improving one's self-image³³, but the donation process is a non-binding commitment, and it is characterized by uncertainty about whether and when a donation opportunity will materialise. This fact can influence an individual's interest in enrolling in a donor registry and may even result in the enrolled individual's refusing to donate when the opportunity arises³⁴⁻³⁶.

The purpose of this study stemmed from these considerations. Our results add new elements that allow us to better understand people's perception of the donation and what feelings and opinions they have regarding this topic. This new knowledge can be of help when developing strategies to increase SC donation and to better understand how to optimize IBMDR's performance in donor recruiting.

The literature proved that the level of knowledge of the SC donation process was one of the main factors favouring the decision to become a donor^{7,30,37,38}. Our

results showed a good level of awareness regarding some general characteristics of SC donation such as its social nature (anonymous, voluntary and free of charge), its organization facilities (IBMDR and donor centers) and its methods (CB, BM and PBSC collection). However, the need to recruit donors was poorly perceived by the population, and the role of voluntary associations and CB banks was not well known. This was described in a literature review on parents' knowledge of CB donation, as well⁷. Stratifying the results by geographical areas, the SIT participants and male respondents proved to have the least knowledge about significant items.

Exploring knowledge on SCs' role and functions in more depth, we found the same trends. Where the comparisons were significant, SIT participants consistently provided lower frequencies of correct answers, and those who provided correct answers were primarily females and those with a lower median age.

Participants had a good knowledge of collection methods used for BM, PBSC and CB harvesting, but as observed before, the level of their knowledge decreased when specific topics of the donation process were explored, such as the need to administer growth factor and anesthesia. Respondents who gave correct answers were younger than those who did not and were more often females; SIT participants had lower frequencies of correct answers. In line with our findings, the correlation between female sex and younger age with higher levels of knowledge, awareness and positive attitude towards SC donation was demonstrated by authors conducting studies in various social contexts^{26,31,37-42}.

Some common beliefs related to the fear of being exposed to risks as a consequence of the donation process (e.g., pain, neurologic consequences, side effects) were explored. Our findings reported a good level of awareness regarding the safety of BM, PBSC and CB donation procedures. Males, older participants and SIT participants gave fewer correct responses.

A notable part of the sample believed that there is a risk of paralysis related to the BM explant procedure and that BM can be harvested in high quantities from the spinal cord and vertebral column. In Italian, the term "bone marrow" is commonly used to refer to the spinal cord. Our results confirmed that the population still does not understand the difference between bone marrow and spinal cord.

Exploring the feelings experienced by the participants when thinking about SC donation, we found that positive feelings such as acceptance, solidarity, enthusiasm, gratification, empathy, satisfaction and a sense of dignity were frequently reported by the participants, while curiosity and exaltation were considerably less frequent. Instead, negative emotions such as fear, anxiety, indifference, grief, hesitation, apprehension, terror, frailty, doubt, uncertainty, vulnerability, refusal and perplexity were less often reported.

However, when stratifying responses on experienced feelings by geographical areas, age and sex, significant relationships emerged. Respondents of the SIT group experienced fewer positive feelings and felt more negative ones. Furthermore, females were more open to SC donation, explained by a higher prevalence of positive emotions like satisfaction, gratification, empathy and a stronger sense of solidarity, although females also reported more fear. This was perfectly in line with findings reported by Switzer and colleagues, who reported that people who experienced positive feelings had more positive pre- and post-donation emotional reactions³⁴. Interestingly, the trend of younger participants to report higher levels of almost all feelings was independent by their gender.

The participants' opinions and values were explored by asking the degree of agreement with some specific sentences through a 5-point Likert scale. The vast majority of participants agreed that HSCT is a life-saving therapy and agreed to the use of SC for research purposes and clinical trials. Many reported that SC donation should be considered by everyone who meets the IBMDR eligibility criteria, and that CB should be collected by default. However, the sample showed various levels of agreement on the proposal that IBMDR registration become mandatory for those who meet the criteria. The majority of respondents agreed that people should receive more information about SC donation, and many of them would like to have information on the recipient's clinical conditions. Only one-third of the sample wanted to know the recipient identity. Unclear correlations emerged from the comparisons by area, sex and age. Those who strongly agreed with the statements appeared to be younger than the others, and females appeared to be more likely to agree. In addition, the larger participation to the survey by SIT residents could highlight an educational need expressed

by these populations on the topic, which could reveal a potential unexpressed will to donate. Interestingly, male respondents who considered themselves less informed about SC donation than did females, agreed that everyone should have more information about it; but they were less willing to attend awareness-raising events organized by institutions as well as significantly less willing to receive further information.

Limitations

While our results confirmed some literature findings on the relationship between population and SC donation, they should be considered with caution because the analyses of the data focused on some variables strictly linked with the local territories and the organization of the Italian National Health Service. In addition, the use of social media to disseminate the questionnaire could have selected participants who were capable to use them, and the recruitment strategy made through hematology networks might have worsened the selection bias. Furthermore, the study involved a large cohort of adult participants without considering various factors that could impact the results. For example, the study included participants who were potential donors as well as those who were not eligible for donation. Furthermore, the topic of the questionnaire and its length could have selected some specific groups of respondents, such as healthcare professionals, students and those who had friends or family members who had undergone HSCT.

CONCLUSION

To our knowledge, this is the first study conducted on this topic in Italy. The study of donor and non-donor characteristics makes it possible to provide useful information for optimising institutional awareness campaigns⁴³. Our findings allowed us to identify a precise profile of subjects who should be systematically targeted by institutions and/or associations for specific education interventions. For example, males under 36 years of age, and living in Southern Italy, were systematically correlated with lower awareness of and interest in SC donation. They are the ones who most need to receive education interventions in the light of what we described in the background regarding the impact of age, sex and HLA matching on HSCT outcome and the probability of having an unrelated donor.

ACKNOWLEDGMENTS

The Authors are delighted to thank the GITMO, the IBMDR, the CNT/CNS, and all the volunteers of AIL, ADMO and ADOCES for all their efforts. A special thank you to Jacqueline Costa for the English language editing of this work.

AUTHORSHIP STATEMENT

Conceptualization: SB, RL and CI. Methodology: SB, RL, and MC. Tool development (questionnaire): SB, RL, SPo, NS, SPu, AV, and LL. Software and social media: CI, AL. Validation: FC, SPo, NS. Formal Analysis: NS, LC, and GDN. Investigation and data collection: all the Authors. Data Curation: SB, LC, DC. Paper draft preparation: SB, RL, LC. Paper review and editing: MM, TR, IR, EV. Supervision: AG, GDN, FC. Project Administration: SB, AC. All Authors have read and agreed to the published version of the manuscript.

The Authors declare no conflicts of interest.

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