



Promotion of Blood Donation: Data Analytics of Moroccan Blood Donors and Non-Donors



ARTICLE INFO

Article Type

Descriptive Study

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How to cite this article

Mouncif C, Bellabdaoui A. Promotion of Blood Donation: Data Analytics of Moroccan Blood Donors and Non-Donors. Health Education and Health Promotion. 2025;13(3):601-606.

ABSTRACT

Aims This study aimed to investigate the perceived importance and effectiveness of various communication strategies for promoting blood donation and to examine their associations with demographic and behavioral factors.

Instrument & Methods This cross-sectional study using face-to-face and online survey was conducted on Moroccan adults aged 18-65 years. Data were cleaned (invalid rate 13.3%) and analyzed in Python, and visualized in Power BI. Associations were tested using Chi-square (χ^2) tests and t-tests, with multivariable logistic regression adjusted for donation status, age, gender, marital status, education, and occupation status.

Findings A total of 664 valid questionnaires (366 donors and 298 non-donors) were included. Donors were significantly older (odds ratio=1.04 per year, $p<0.001$) and more educated (odds ratio=1.32 per level, $p=0.001$), while non-donors were younger and single. Regarding blood need and urgency, donors were more likely to have personally needed blood (odds ratio=1.28 per level, $p=0.003$). Gender and occupation were not independent predictors ($p>0.05$). In terms of promotion strategies, digital platforms, such as social media engagement (odds ratio=1.49, $p=0.033$) increased the odds of being a donor, whereas the use of mobile applications (odds ratio=0.55, $p<0.001$) and appointment/traceability systems (odds ratio=0.68, $p=0.009$) decreased those odds.

Conclusion Social media and in-person outreach improves donor recruitment and retention methods.

Keywords Blood Donor; Blood Donation; Motivations; Incentives; Communication; Data Analytics

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Article History

Received: July 8, 2025

Accepted: September 19, 2025

ePublished: September 23, 2025

CITATION LINKS

[1] Blood safety and ... [2] Motivations and obstacles of the individual towards blood donation ... [3] The management of blood donation ... [4] Blood donation in Morocco: A strategic study of two decades of donor promotion ... [5] The promotion of blood donation is a societal ... [6] Study of blood donation campaign communication methods and attributes of ... [7] Boosting blood donations through Facebook engagement ... [8] Blood donor satisfaction and intention ... [9] Exploring the pattern of blood donor beliefs in first-time, novice ... [10] Integrating self-determination theory and the ... [11] Demographic variations in blood donor deferrals ... [12] Knowledge, attitude and practice of blood donation and the role of religious beliefs ... [13] A data analytics study for adverse reactions of blood donors ... [14] Blood donation mobile applications ... [15] Efficacy of communication interventions for promoting ... [16] How to encourage non-donors to be more willing to donate ... [17] Moroccan population ... [18] Determining appropriate sample size ... [19] A systematic review and meta-analysis of antecedents ... [20] Donating blood: A meta-analytic review ... [21] A systematic review of incentives ... [22] Recruitment and retention of blood donors in four Canadian cities ... [23] Factors influencing blood donation ... [24] Promoting blood donation through social media ... [25] Is WhatsApp effective at increasing the return rate of blood ... [26] Effects of message framing on recruiting Rh-D-negative blood donors ... [27] Strategies to recover blood donors during the COVID-19 pandemic ... [28] Explaining voluntary blood donation from a communication ... [29] A framework for a smart social blood donation system based ... [30] Social media usage and strategies in motivating various ...

Introduction

Blood transfusion is an integral component of contemporary medicine and is crucial in the management of trauma, surgical interventions, chronic disease management, and maternal and pediatric health. Globally, approximately 120 million blood units are collected annually; however, there are still considerable variations in the rate of donations per region, according to the World Health Organization (WHO). High-income countries achieve approximately 31.5 donations per 1,000 people, while low-income regions and Africa report rates of approximately 5.0 and 5.2, respectively, falling well below the WHO's recommended minimum of 10 units per 1,000 population. These gaps contribute to preventable mortality, compounded by blood's limited shelf life and the ongoing need for sustained donor recruitment [1].

In Morocco, despite all attempts to promote blood donation, the country still suffers from a shortage of voluntary resources, with a donation level that does not exceed 0.92% at the national level, which is less than the WHO's target of 1 to 2%. This often results in blood reserves being limited to a mere 6 to 7 days of autonomy [2]. Initiatives, like Ramadan mosque-based blood drives highlight efforts to address shortages, but cultural and logistical barriers necessitate evidence-based strategies to enhance voluntary donation systems [3]. This structural deficit frequently leads to chronic shortages, especially during health crises or periods of high seasonal demand.

To improve blood donation in Morocco, institutional initiatives have been introduced, including mobile donation, the promotion of voluntary donation, and awareness campaigns implemented in mosques [2, 4, 5]. Furthermore, data-driven communication strategies significantly improve donation attitudes and behaviors through targeted campaigns [6, 7]. Blood donation in Morocco encounters particular challenges such as cultural beliefs, trust in the national health system, and low accessibility, which the current mobilization campaigns have had difficulty addressing effectively [5].

Various communication strategies, such as television, apps, social media [8, 9], mail, SMS (or text messages), telephone [10], and the Internet and websites [11, 12], can all help promote blood donation and encourage people to donate blood. Appointment scheduling and real-time updates on blood shortages can also be effective [13, 14].

Community-based strategies, such as face-to-face outreach and educational workshops, further enhance donor engagement by fostering trust and addressing local concerns [15, 16]. The study aims to examine and evaluate the effectiveness of communication strategies for promoting blood donation among both blood donors and non-donors in Morocco.

Through a national survey of 766 individuals, this research aimed to identify determinants such as cultural beliefs, trust, and accessibility that could help address the problem of low donor engagement. Utilizing sophisticated data analysis tools, such as Power BI and Python, the study aims to analyze the data in a way that guides policy and strategy consistent with the 2025 WHO Global Framework for Blood Safety, with the purpose of informing evidence-based interventions and providing a comprehensive perspective on donation practices.

Instrument and Methods

Study design and sample

This cross-sectional study using face-to-face and online survey was conducted on Moroccan adults aged 18-65 years in April 2022. According to the latest Moroccan population statistics [17], the adult population (ages 18-65) was approximately 22 million. Using [18] guidelines for survey research, the representativeness of our sample was justified by applying the following Cochran's formula for large populations:

$$n = \frac{Z^2 \cdot p \cdot (1 - p)}{e^2} = \frac{(1.96)^2 \cdot 0.5 \cdot 0.5}{(0.05)^2} = 384$$

Z=1.96 (Z-score for 95% confidence level)

p=0.5 (maximum variability)

e=0.05 (5% margin of error)

The minimum required sample size was 384, which means that 766 exceeds this threshold, enhancing statistical power. This aligns with blood donation studies that typically use 300-1,000 respondents [19], supporting its validity for analyzing trends among blood donors and non-donors.

All participants were between 18 and 65 years old and were mentally competent. Only Moroccan citizens participated in the study. In the analysis, incomplete questionnaires with missing values in more than 70% of the questions or those with obviously contradictory answers were excluded.

Instrument

To achieve a thorough understanding of blood donation management across the country, we created a questionnaire survey with a sample size of 766 participants. To ensure active participation, the questions were designed in a simple format to minimize errors in the findings. The questionnaire was based on previous studies [20, 21]. The revised questionnaire was reviewed by blood donation experts to ensure content validity. A second pilot test with a new sample is recommended to verify improvements in clarity (target≥4.0), relevance (target≥4.5), and reliability (Cronbach's alpha≥0.7). The pilot test demonstrated that the questionnaire, with revisions, is a promising tool for assessing blood donation management in Morocco.

All questionnaires were anonymous. It was believed that explaining the purpose of the study to participants would help ensure that they answered all questions honestly. Participants were also informed that this was a completely voluntary process. Each question was carefully reviewed to ensure that it would not negatively impact participants' interests or beliefs. In addition, completion of the questionnaire was considered confirmation of consent to participate in the research study.

Data collection: This study was reviewed and approved by blood donation experts to ensure content validity. Verbal consent was obtained from all participants. Furthermore, completion of the questionnaire was considered confirmation of consent to participate in the research study.

A mixed-mode strategy was used to ensure a representative and diverse sample. In the face-to-face recruitment, we approached potential participants in public squares, universities, and community centers across several Moroccan cities. We explained the study's objectives, ensured eligibility, and distributed paper questionnaires to those who consented to participate. In the online recruitment, a digital version of the questionnaire, identical in content, was disseminated through Moroccan social media groups, forums, and professional mailing lists. Participants were asked to share the survey link within their networks to promote a snowball sampling technique. In both modes, participants were informed that their

participation was voluntary and anonymous. Proceeding to the questions after reading the study information was considered implied consent.

Data analysis: Survey data was entered into a Microsoft Excel spreadsheet and then analyzed using Python. To automate database maintenance and updating, we developed code in Python that allows data to be processed automatically. An algorithm was developed in the Python programming language using the pandas, re, and statsmodels libraries. Additionally, Power BI was used to construct interactive dashboards and graphical displays for performing comprehensive and accurate analyses of participant data. Statistical significance was assessed using chi-square tests for categorical parameters and t-tests for continuous parameters, with a significance threshold of $p < 0.05$. Logistic regression models, adjusted for age, gender, education, and occupational status, quantified the strength of associations, along with visualizations to support interpretation.

Findings

A total of 766 questionnaires were gathered, with 414 (53.9%) from blood donors and 354 (46.1%) from non-donors. Following data cleaning, 102 questionnaires (13.3%) were discarded due to being invalid, defined as having 70% or more missing data or containing contradictory answers. As a result, 664 valid questionnaires remained for analysis, consisting of 366 (55.12%) from donors and 298 (44.88%) from non-donors.

Table 1. Frequency of demographic and socio-economic characteristics of donors and non-donors

Parameter	Donors	Non-donors	p-Value
Gender			0.188
Female	214 (58.47)	189 (63.42)	
Male	152 (41.53)	109 (36.58)	
Age (year)			<0.001
18-22	58 (15.86)	106 (35.60)	
23-30	132 (36.07)	105 (35.23)	
31-40	113 (30.87)	59 (19.80)	
41-50	32 (8.74)	10 (3.36)	
51-60	23 (6.28)	2 (0.67)	
≥61	8 (2.19)	4 (1.34)	
Education level			<0.001
High school diploma	20 (5.36)	14 (4.65)	
High school to associate degree	49 (13.39)	79 (26.36)	
Associate degree to bachelor's degree	142 (38.69)	120 (40.31)	
Bachelor's to master's degree	145 (39.58)	75 (25.19)	
Master's to Phd	11 (2.98)	10 (3.49)	
Occupational status			<0.001
Student	181 (49.45)	195 (65.44)	
Employed	145 (39.62)	81 (27.18)	
Housewife	22 (6.01)	13 (4.36)	
Retired	10 (2.73)	5 (1.68)	
Unemployed	8 (2.19)	4 (1.34)	
Marital status			<0.001
Single	221 (60.38)	240 (80.54)	
Married	136 (37.16)	50 (16.78)	
Divorced	8 (2.19)	5 (1.68)	
Widowed	1 (0.27)	3 (1.01)	
Frequency of blood need			0.002
Never	175 (47.80)	155 (52.07)	
Rarely	85 (23.08)	76 (25.35)	
Sometimes	60 (16.48)	38 (12.90)	
Often	24 (6.59)	26 (8.76)	
More often	22 (6.04)	3 (0.92)	

Table 2. Logistic regression analysis of predictors of blood donor status

Parameter	p-Value	Odds ratio	95% confidence interval
Age	<0.001	1.04	1.02-1.06
Education	0.001	0.32	1.12-1.56
Marital status			
Single (Ref)	<0.001	2.15	1.48-3.12
Need for blood	0.003	1.28	1.09-1.51
Gender			
Female (Ref)	0.421	0.87	0.62-1.22
Occupational status			
Student (Ref)	0.064	1.42	0.98-2.06

Table 3. Analysis of percentages of communication strategy effectiveness for blood donation recruitment

Communication strategies	Donation status		Gender		Age (year)						Occupational status				
	Donor	Non-donor	Female	Male	18-22	23-30	31-40	41-50	51-60	61+	Student	Housewife	Retired	Unemployed	Employed /active
Mail and SMS	78.14	74.83	77.17	75.86	79.55	76.37	76.74	73.81	64.00	75.00	77.93	62.86	66.67	73.33	77.43
Local and national press	76.50	72.15	74.44	74.71	73.86	76.79	75.00	66.67	68.00	75.00	75.53	65.71	66.67	73.33	74.78
Media (TV, radio, etc.)	86.34	82.89	84.12	85.82	84.09	87.76	81.40	90.48	68.00	100	85.37	65.71	91.67	93.33	85.84
Social media networks	89.62	85.23	87.84	87.36	90.34	90.30	86.05	85.71	64.00	75	89.63	71.43	66.67	93.33	87.84
Presence in: Events, supermarkets, fairs, weekly souk	84.43	78.19	81.14	82.38	84.09	80.59	81.40	83.33	72.00	83.30	82.98	62.86	75.00	80.00	82.74
Appointments, management, & traceability	45.08	54.36	48.14	50.96	77.27	31.22	45.93	47.62	48.00	50.00	51.33	31.43	50.00	33.33	49.56
Mobile application	45.90	60.40	53.35	50.96	77.84	39.24	45.93	50.00	40.00	66.67	55.32	34.29	66.67	33.33	50.88

Donors were typically older, with 36.07% aged 23-30 and 30.87% aged 31-40, compared to non-donors, who were predominantly younger (35.60% aged 18-22). In addition, donors were more educated, with 39.58% holding bachelor's to master's degrees, while non-donors included 26.36% with high school to 2-year degrees. Occupationally, 39.62% of donors were employed, compared to 27.18% of non-donors, and 37.16% of donors were married, compared to 16.78% of non-donors. Regarding blood need frequency, donors also reported a higher percentage than non-donors (6.04% "more often" vs. 0.92% for non-donors; Table 1).

Table 4. Adjusted odds ratios for communication strategies and donation status

Communication strategy	Adjusted odds ratio	95% confidence interval	p-Value
Mail and SMS	1.21	0.98-1.64	0.224
Local/national press	1.25	0.92-1.70	0.151
Traditional media (TV and radio)	1.31	0.94-1.83	0.108
Social media	1.49	1.03-2.16	0.033
Events/supermarkets	1.45	1.04-2.02	0.027
Appointments/traceability	0.68	0.51-0.91	0.009
Mobile application	0.55	0.41-0.73	<0.001

The logistic regression model was statistically significant ($X^2=78.42$, $p<0.001$), explaining 22.7% of the variance in donor status (Nagelkerke $R^2=0.227$). Donors were more likely to be older, with odds increasing by 4% for every year of age (OR=1.04, 95% CI: 1.02-1.06, $p<0.001$). Higher education levels were associated with a 32% increased likelihood of donation per level (OR=1.32, 95% CI: 1.12-1.56,

$p=0.001$). Married individuals were 2.15 times more likely to donate blood compared to single individuals (OR=2.15, 95% CI: 1.48-3.12, $p<0.001$). Furthermore, there was a 28% higher chance of donating for those who required more blood transfusions (OR=1.28, 95% CI: 1.09-1.51, $p=0.003$; Table 2).

There were associations between communication effectiveness strategies and donation status, gender, age groups, and occupational status (Table 3).

Engagement with social media was significantly associated with being a donor (OR=1.49, 95% CI: 1.03-2.16, $p=0.033$), indicating its effectiveness in motivating blood donation, particularly among younger participants (90.34% for ages 18-22, $p<0.05$). Presence at events and supermarkets was also significantly associated with donation status (OR=1.45, 95% CI: 1.04-2.02, $p=0.027$). Engagement with mobile applications was inversely associated with donation status (OR=0.55, 95% CI: 0.41-0.73, $p<0.001$), with non-donors reporting higher usage (60.40% vs. 45% among donors). Similarly, engagement with appointment and traceability systems was inversely associated with donation (OR=0.68, 95% CI: 0.51-0.91, $p=0.009$). Mail, SMS, and local/national press showed no significant association with donation status ($p=0.224$ and $p=0.151$, respectively), suggesting moderate but not targeted impact. Chi-square tests revealed significant differences in engagement based on age groups ($p<0.001$) and occupational status ($p<0.05$), with younger participants (ages 18-22) and students showing higher engagement with social media (90.34% and 89.63%, respectively) and mobile applications (77.84% and 55.32%; Table 4).

Discussion

This study aimed to investigate the perceived importance and effectiveness of various communication strategies for promoting blood donation. It provides a comprehensive analysis of blood donation dynamics in Morocco, revealing critical insights into donor demographics, socio-economic characteristics, and communication strategies. Our results are consistent with and extend prior research in transfusion medicine, providing subtle implications for the recruitment and retention of donors in comparable settings.

There was a predominantly young, well-educated, and largely female group of participants. Donors tended to be older, more educated, and more likely to have jobs and be married compared to those who do not donate. These differences in demographics are similar to patterns seen in studies from Canada [22], China [23], and Morocco [4], where Moroccan blood donors exhibit comparable trends. However, the gender breakdown stood out, hinting at shifting donor characteristics. Meanwhile, the predominance of younger non-donors points to ongoing challenges in recruiting donors, a common issue in lower-income countries (LIC) [15]. Keeping track of how donor profiles change over time can serve as a useful indicator of campaign effectiveness, especially when tied to sustained promotional efforts [3].

Our findings revealed critical insights into communication preferences for blood donation initiatives, aligning with and differing from other evidence-based strategies in the literature. Participants prioritized digital platforms, such as mobile applications (with non-donors showing a significant preference) and social media (which showed a significant association with donation status among donors), both of which are frequently rated as highly important for awareness. This mirrors their documented success in boosting donations [24], particularly in low- and middle-income countries (LMICs) [25], and in improving donor retention [14]. However, traditional media (TV/radio) consistently demonstrated superior real-world engagement across diverse demographic characteristics. These paradoxes highlight an ongoing digital divide, where the acceptance of mobile tools remains low among important demographics, such as housewives and students, despite the high perceived value of apps.

The unexpectedly low performance of SMS showed no significant association with donation status and lacked targeted impact, compared to its established efficiency elsewhere [6], underscoring the importance of the specific local setting and the framing of the message [15, 26]. Conversely, face-to-face outreach proves universally effective, which supports the use of mobile collection units [27, 28], and is even more effective in the case of older donors. Furthermore, current donors prefer passive awareness channels (such as traditional media and social networks),

while non-donors prefer active platforms, such as appointment systems, demonstrating that active platforms could be key to changing individuals' minds [29]. Culturally, there are differences between generations in how they respond to various communication methods. For example, traditional media appeals more to older demographics, while social media engagement differs, with live sessions engaging 72% of Generation X and 49% of Generation Z, as demonstrated by Ravula *et al.* [30]. This suggests that segmented, multi-channel strategies are needed to address both digital accessibility gaps and behavioral preferences.

The main strength of this study lies in its large and diverse sample of 766 individuals, including both blood donors and non-donors. Its comprehensive analysis of the factors that promote blood donation provides an extensive view of the blood donation ecosystem in Morocco. However, limitations such as urban bias in the sample necessitate caution in generalizing the results. Future research directions should take these limitations into consideration and prioritize larger randomized cohorts that include student participants. In addition, longitudinal studies using hierarchical prediction could further improve recruitment and retention strategies. Finally, employing machine learning to analyze factors influencing youth engagement in blood donation, especially among students, across diverse Moroccan contexts would be beneficial.

Boosting blood donation rates in Morocco requires a tailored, evidence-based strategy. By recognizing the unique profiles and the effectiveness of communication strategies for donors and non-donors, blood service organizations can shift from broad campaigns to focused, culturally relevant, and digitally enhanced approaches. A stronger, sustainable blood supply hinges on closing the gap between awareness and action, equipping potential donors with knowledge and confidence, and aligning communication with the diverse needs of different population groups.

Conclusion

Social media and in-person outreach improves donor recruitment and retention methods.

Acknowledgments: We extend our heartfelt gratitude to everyone who contributed to this research. In particular, we would like to acknowledge all participants in this study.

Ethical Permissions: This research received ethical permission from the Ethics Committee of the ITM research team (Approval Reference: ITM/REC/220506).

Conflicts of Interests: The authors reported no conflicts of interests.

Authors' Contribution: Mouncif C (First Author), Main Researcher/Introduction Writer//Methodologist/Discussion Writer/Statistical Analyst (80%); Bellabdaoui A (Second Author), Assistant Researcher/Introduction

Writer/Methodologist/Discussion Writer/Statistical Analyst (20%)

Funding/Support: The authors declares that no funds, grants, or other support were received for this research.

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