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Knowledge, attitudes, and practices toward blood donation among donors: A cross-sectional study

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Knowledge, attitudes, and practices toward blood donation among donors: A cross-sectional study

Running title: KAP of blood donors

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ABSTRACT

Objective: To evaluate the knowledge, attitudes, and practices (KAP) toward blood donation among blood donors.

Design: A cross-sectional study was conducted.

Setting: The study surveyed voluntary blood donors in Shaoxing, Zhejiang.

Participants: A total of 580 voluntary blood donors participated in the survey between May 2024 and June 2024.

Interventions: An investigator-designed questionnaire was administered to collect demographic data and assess participants' KAP regarding blood donation.

Primary and Secondary Outcome Measures: The primary outcome measures included knowledge, attitude, and practice scores of blood donors.

Results: Analysis revealed a mean knowledge score of 19.37 ± 4.05 (possible range: 0-22), an attitude score of 46.28 ± 4.45 (possible range: 10-50), and a practice score of 23.37 ± 5.67 (possible range: 6-30). Knowledge scores correlated positively with attitude ($r = 0.580$, $P < 0.001$) and practice scores ($r = 0.494$, $P < 0.001$). Furthermore, attitude scores showed a strong correlation with practice scores ($r = 0.618$, $P < 0.001$). Structural equation modeling indicated that knowledge directly influenced attitudes ($\beta = 0.622$, $P = 0.007$) and had an indirect influence on practices ($\beta = 0.411$, $P = 0.005$). Attitudes directly influenced practices ($\beta = 0.661$, $P = 0.006$).

Conclusions: Blood donors exhibited good knowledge and positive attitudes, but their practices were suboptimal. These findings highlight the need for targeted interventions to enhance participation in blood donation.

Keywords: blood donation; blood donors; health knowledge, attitudes, practices; cross-sectional study; China.

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Strengths and limitations of this study

Strengths:

- The study involved 580 voluntary blood donors, providing a robust dataset that enhances the reliability and generalizability of the findings.
- The strong correlations among knowledge, attitudes, and practices reveal significant relationships, indicating that improved knowledge and attitudes could enhance blood donation practices.

Limitations:

- The study's cross-sectional design limits the ability to establish causality between knowledge, attitudes, and practices regarding blood donation.
- Relying on self-reported questionnaires may introduce biases, affecting the accuracy of the knowledge, attitudes, and practices reported by participants.

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INTRODUCTION

Blood donation is paramount in global healthcare, with over 100 million blood units contributed annually. The availability of blood units is crucial for patients undergoing surgery, coping with trauma, managing chronic illnesses, and battling cancer. This essential procedure is a lifeline for many patients, sustaining and saving lives [1]. The two primary uses of blood units are for anemia correction and acute blood loss [1]. Blood donation is essential for maintaining blood banks, and declining donation rates can compromise the proper management of patients with trauma, those undergoing major surgeries, and patients with transfusion-dependent conditions (e.g., transfusion-dependent thalassemia) [2, 3]. The World Health Organization (WHO) estimated that at least 1% of a nation's population should voluntarily donate blood to meet the basic requirement for blood and its products [4]. The high prevalence of chronic infections in some regions (e.g., hepatitis B and C) [5, 6] and the use of certain medications, can also limit blood donations [7, 8]. The donor must also meet fitness criteria (e.g., minimum allowable hemoglobin level, a normal body temperature) and wait for the proper interval to replenish iron stores [9, 10]. Furthermore, offering incentives for blood donation appears economically inefficient [2].

In addition to medical contraindications and regional incentives, individual knowledge and motivation play key roles in blood donation. Blood donation is a voluntary process, and while publicity campaigns can influence donation rates, a person's knowledge of the importance of blood donation and their attitudes toward it are major factors influencing their practice of donating blood. Knowledge, attitude, and practice (KAP) surveys can be used to identify gaps, misunderstandings, and misconceptions that can constitute barriers to the optimal performance of a specific set of actions in a specific population [11-13]. Previous KAP studies explored the domain of voluntary blood donation, including the reasons for donating blood or not, sources of knowledge, motivating and demotivating factors for voluntary blood donation, and the

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impact of peer structure on potential donors, among others [14-25]. Still, those factors can vary widely among different regions of the world, even within a country, due to differences in economic conditions, education, healthcare systems, culture, and various socioeconomic factors. Therefore, it is essential to perform KAP studies in specific areas to design interventions specific to those areas.

Therefore, the present study aimed to evaluate the KAP toward blood donation among blood donors in Zhejiang province, located in the economically developed southeastern region of China. The results could provide useful insights for blood donation management and education.

METHODS

Study design and participants

This cross-sectional study enrolled voluntary blood donors at the Shaoxing Central Blood Station in Shaoxing, Zhejiang province, China, between May 2024 and June 2024. The study was approved by the Ethics Committee of Shaoxing Central Blood Station (approval no. (2024) 1). Written informed consent was obtained from all participants.

The inclusion criteria were: 1) voluntary blood donors, 2) willingness to participate in the study, and 3) age >18 years. Participants aged over 60 years were included.

Questionnaire design

The initial questionnaire draft was designed based on the literature [14-23]. The questionnaire was then revised based on feedback from two experts in the Zhejiang province blood donation system. The questionnaire underwent a preliminary survey and reliability testing, achieving a reliability score of 0.883. The participants were asked to indicate any question, word, or item that was difficult to understand to ensure face validity.

The final questionnaire was in Chinese and consisted of four sections: demographic data, knowledge dimension, attitude dimension, and practice dimension. Basic demographic

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information included gender, age, body mass index (BMI), local registered residence, place of residence, education, occupation, marital status, childbearing status, type of blood donation, number of times donated , main reasons for donating blood, and information sources about blood donation. The knowledge dimension included 11 items, with responses scored as “very knowledgeable” = 2 points, “heard of it” = 1 point, and “not clear” = 0 points, resulting in a total score range of 0-22 points. The attitude dimension contained 10 questions scored using a five-point Likert scale, with positive statements scored from “strongly agree” = 5 points to “strongly disagree” = 1 point, resulting in a total score range of 10-50 points. The practice dimension consisted of seven questions, with the first question analyzed descriptively but not scored, and questions 2-7 scored from “never” = 1 point to “always” = 5 points, resulting in a total score range of 6-30 points. Scores in each dimension exceeding 80% of the total score were considered sufficient knowledge, favorable attitude, and proactive practice [13, 26].

Questionnaire distribution

The questionnaire was uploaded to the Questionnaire Star platform, and a QR code was generated. The QR code was distributed to participants through the Shaoxing Central Blood Station, various blood donation centers (Lingchao Philanthropy Blood Donation Center, Shaoxing Love Blood Donation Center, Keqiao Love Blood Donation Center), WeChat groups (Shaoxing Central Blood Station “Board Friends Home” group, Shaoxing College Platelet Alliance), the researcher’s WeChat Moments, and mobile blood donation vehicles. Participants completed the questionnaire independently. To ensure data integrity, each IP address was limited to submitting one response, and all questions were mandatory for submission.

A trap question (“10+10=30”) was included, and questionnaires with “true” selected for this question were considered invalid. Questionnaires with obvious errors (e.g., impossible age) or filled in an obvious pattern (e.g., all first choices) were excluded. All questionnaires were filled out anonymously.

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Sample Size

A single population proportion formula, $n=[(Z_{\alpha/2})^2*P(1-P)]/d^2$, was used to calculate the sample size. Since no prior KAP scores on blood donation among Chinese blood donors were available, the sample size for this study was calculated based on an expected proportion of 50%, with a confidence level of 95% and a margin of error of 5%, requiring a sample size of 384 individuals. Considering a 20% drop-out rate, a total of 480 individuals were required.

Statistical analysis

Statistical analysis was performed using SPSS 27.0 and AMOS 26.0 (IBM, Armonk, NY, USA). Continuous variables were expressed as means ± standard deviations and analyzed using the Mann-Whitney U-test or Kruskal-Wallis H-test. Categorical variables were expressed as n (%). Spearman correlation analysis was used to assess the relationship between KAP dimensions. A structural equation modeling (SEM) analysis was conducted to test the following hypotheses that: (H1) knowledge directly affects attitude, (H2) knowledge directly affects practice, and (H3) knowledge indirectly affects practice through attitude. The model fit indices for SEM were evaluated against the following thresholds: minimum discrepancy function by degrees of freedom divided (CMIN/DF); root mean square error of approximation (RMSEA); standardized root mean square residual (SRMR); Tucker–Lewis index (TLI); and comparative fit index (CFI). P-values <0.05 were considered statistically significant.

RESULTS

Characteristics of the participants

The study enrolled 580 participants with valid questionnaires. Genders were approximately equally represented, with 48.45% male and 51.55% female. The majority of participants were over 40 years old (34.83%), had a BMI <24 kg/m^2 (51.21%), were registered residents of Shaoxing City (62.41%), lived in urban areas (58.79%), had an associate degree education or

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above (70.34%), were not single (59.83%), had children (58.62%), were donating whole blood (84.31%), and had donated more than once (72.76%) (Table 1). Supplementary Figure S1 shows that the main reason for donating blood (at the time of the survey) was selfless contribution and helping others. Supplementary Figure S2 shows that the main source of information about blood donation was volunteer public welfare activities.

Knowledge

The mean knowledge score was 19.37±4.05 (possible range: 0-22) (Table 1). The knowledge scores were significantly associated with age (P=0.003), city registration (P<0.001), education (P=0.007), occupation (P<0.001), marital status (P=0.046), children (P=0.017), type of blood donation (P<0.001), and the number of donations (P<0.001) (Table 1). The two knowledge items with the lowest scores (yet still above 80%) were related to the target population for blood donation (K1) and the optimal interval between donations (K2) (Table 2).

Attitudes

The mean attitude score was 46.28±4.45 (possible range: 10-50) (Table 1). The attitudes scores were significantly associated with age (P<0.001), BMI (P=0.044), education (P=0.023), occupation (P<0.001), marital status (P<0.001), children (P<0.001), and number of blood donations (P<0.001) (Table 1). All attitude items showed high scores. The lowest score was observed regarding the expectation of receiving some form of return after blood donation (A4) (Table 3).

Practice

The mean practice score was 23.37±5.67 (possible range: 6-30) (Table 1). The practice scores were significantly associated with gender (P=0.016), age (P<0.001), BMI (P=0.044), education (P=0.023), occupation (P<0.001), marital status (P=0.011), children (P=0.005), type of blood donation (P=0.004), and the number of blood donations (P<0.001) (Table 1). The lowest practice scores were observed regarding making an appointment online for blood donation (P4),

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encouraging others to donate blood (P3), propagating knowledge about the benefits and significance of blood donation (P2), and taking the initiative to learn more about blood donation (P5) (Table 4).

Correlations

As shown in Table 5, knowledge scores were correlated to the attitude (r=0.580, P<0.001) and practice (r=0.494, P<0.001) scores. The attitude scores were correlated to the practice scores (r=0.618, P<0.001).

SEM analyses

Supplementary Table S1 shows that the fit of the model was good. As shown in Supplementary Table S2, knowledge significantly influenced attitudes (β=1.226, P<0.001), and attitudes significantly influenced practice (β=0.787, P<0.001). The mediation analysis showed that knowledge had a direct influence on attitudes (β=0.622, P=0.007) but only an indirect influence on practice (β=0.411, P=0.005). Attitudes had a direct influence on practice (β=0.661, P=0.006) (Figure 1 and Supplementary Table S2).

DISCUSSION

This study suggests that blood donors had good knowledge and positive attitudes, but suboptimal practices toward blood donation. Such data could be used to design interventions to increase participation in blood donation in Zhejiang.

In the present study, the participants had good knowledge and positive attitudes. Such results are not surprising since the study was performed on blood donors, and the majority had donated blood more than once. A study in 16 Arabic countries showed that university students had poor knowledge and low donation rates, but positive attitudes toward blood donation [27], while studies in India [28] and Saudi Arabia [29] showed higher knowledge levels. Knowledge of the societal benefits of blood donation and positive attitudes are essential for blood donors

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since blood donation is voluntary [2]. Even medical students were reported to have poor knowledge about blood donation, yet maintain positive attitudes [15, 16, 18]. It has been suggested that regular blood donation camps should be organized to spread the knowledge about blood donation and motivate eventual new donors [17].

In the present study, the practice score was below (but near) the 80% threshold, indicating that some improvements might be necessary to optimize blood donation in Zhejiang. Although contraindications for blood donation are screened in the donation process, some knowledge of them can help promote the right knowledge in one's surroundings. Again, since the study was performed on regular blood donors, those with contraindications were screened out in the past. The slightly suboptimal practice could also be related to time constraints associated with blood donation (e.g., commuting to a donation center, taking time for the whole blood donation process, and waiting after blood donation to avoid side effects like dizziness and falls). Of course, it is expected that blood donors will have higher KAP scores than non-donors or the general population. Indeed, poor knowledge and practice of blood donation have been observed in the general population in several areas [24, 25]. Previous studies showed that the main reasons for not participating in blood donation were the fear of needles, the sight of blood, concerns about safety and adverse effects, disapproval from peers, and never having been asked for [15, 16, 20]. In 16 Arabic countries, the main barriers to blood donation were: not being asked (37%), ineligibility (33%), fear of pain or infection (18%), concerns about negative health effects (18%), difficulty accessing donation centers (15%), and medical mistrust (14%) [27]. In the present study, the main motivation of blood donors for blood donation was selfless action that helps others. Future studies should be performed on the general population and should compare blood donors and non-donors. A better grasp of the factors associated with poor KAP toward blood donations and of the actual barriers to blood donation could be

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identified. Of note, many donors donate blood a single time without becoming regular donors [29-31]. That aspect should also be investigated to improve the regular donation rate.

In the present study, the majority of the participants were older, well-educated professionals, probably biasing the results toward a better KAP toward blood donation. Eltewacy et al. [27] reported that among university students in 16 Arabic countries, private and international university enrollment was associated with higher knowledge, while non-health science college students had lower knowledge, and participants > 20 years old were more likely to donate while being female, having congenital or chronic diseases, and low knowledge of blood donation were associated with poor practice of blood donation. The socioeconomic status is associated with healthcare literacy [32]. Age was also reported to be associated with better blood donation practice [28, 33]. The female gender was associated with lower practice scores in the present study, as previously reported [27]. The lower practice in females could be related to cultural taboos about women donating blood [34]. Lower blood iron levels during menstruation [35] can also influence the eligibility for blood donation, complicating the donation process due to attention to donation timing. In addition, the weight eligibility criteria and side effects such as dizziness can be barriers to women donating blood despite higher altruism than in men [36]. Indeed, in the present study, a lower BMI was associated with lower practice scores. In the present study, since all participants were blood donors with a favorable socioeconomic status, it is possible that they were more willing to participate in blood donation. Again, a future study should include both blood donors and non-donors.

In the present study, knowledge influenced attitudes, which influenced practice. It is consistent with the KAP theory, stipulating that knowledge is the basis for knowledge while attitudes are the force driving practice [11, 12]. On the other hand, knowledge did not directly influence practice. Hence, those results could suggest that the key to improving practice would be to

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directly motivate individuals to participate in blood donation, facilitate the process, and increase the opportunities for blood donation.

The present study had limitations. The participants were from a single area, limiting the generalizability of the results. The questionnaire was designed by the investigators based on local practices, culture, and policies, limiting the generalizability of the results and the exportability of the questionnaire. The study was cross-sectional, preventing the analysis of causality. Still, a SEM analysis was performed as a surrogate of causality, but the results must be taken cautiously because causality is statistically inferred rather than observed [37-39]. Finally, the social desirability bias can affect the results. Since the knowledge scores were high, there is a possibility that some participants might have answered what they knew they had to think or do instead of what they were really thinking or doing [40, 41]. Finally, this study enrolled blood donors, and the KAP status of the general population remains unknown.

In conclusion, blood donors had good knowledge and positive attitudes, but suboptimal practices toward blood donation. These findings could inform the development of interventions aimed at increasing blood donation participation.

Declarations

Ethics approval and consent to participate

All procedures were performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. The study was approved by the Ethics Committee of Shaoxing Central Blood Station (approval no. (2024) 1). Written informed consent was obtained from all participants. The study was carried out in accordance with the applicable guidelines and regulations.

Consent for publication

Not Applicable

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Availability of data and materials

All data generated or analysed during this study are included in this published article

Competing interests

None

Funding

None

Authors' contributions

Lingling Jiang 、Xiaolei Zhong and Shoubing Zhu carried out the studies, participated in collecting data, and drafted the manuscript. Qichao Mao and Fang Yuan performed the statistical analysis and participated in its design.Nuo Li and Haiyan Luo participated in acquisition, analysis, or interpretation of data and draft the manuscript. All authors read and approved the final manuscript.

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The Patient and Public Involvement statement

No patient or public involved in this study.

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Figure Legends

Figure 1. Structural equation modeling analysis

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Table 1. Characteristics of the participants

Variables	n (%)	Knowledge	P	Attitudes	P	Practices	P
Total score	**n=580**	19.37±4.05		46.28±4.45		23.37±5.67	
Gender			0.250		0.717		0.016
Male	281 (48.45)	19.02±4.49		46.05±4.84		23.92±5.66	
Female	299 (51.55)	19.70±3.57		46.49±4.05		22.85±5.64	
Age (years)			0.003		<0.001		<0.001
18-29	214 (36.9)	19.36±3.78		45.40±4.84		22.57±6.02	
30-39	164 (28.28)	18.92±4.45		46.39±4.42		22.79±6.02	
≥40	202 (34.83)	19.75±3.97		47.13±3.86		24.68±4.69	
Body mass index (kg/m^2)			0.164		0.510		0.044
<24	297 (51.21)	19.51±3.75		46.21±4.42		23.00±5.63	
24-27.9	171 (29.48)	19.18±4.44		46.28±4.62		23.64±5.23	
28-34.5	61 (10.52)	19.54±4.53		46.90±4.21		25.10±5.32	
≥35	51 (8.79)	19.02±3.80		45.96±4.45		22.51±7.19	
Registered resident of Shaoxing City			<0.001		0.084		0.186
Yes	362 (62.41)	19.65±4.06		46.69±4.26		23.62±5.55	
No	218 (37.59)	18.90±4.00		45.61±4.69		22.94±5.85	
Place of residence			0.238		0.126		0.476
Rural	175 (30.17)	19.03±4.20		46.08±4.62		23.33±5.63	
Urban	341 (58.79)	19.62±3.83		46.57±4.23		23.54±5.63	
Suburban	64 (11.03)	18.94±4.67		45.30±5.03		22.55±5.99	
Education level			0.007		0.009		0.023
Middle school and below	77 (13.28)	17.91±5.16		45.06±4.90		22.49±5.18	
High school/technical secondary school	95 (16.38)	19.76±3.81		46.95±4.32		24.60±5.36	
Associate degree and above	408 (70.34)	19.56±3.81		46.36±4.36		23.25±5.79	
Occupation			<0.001		<0.001		<0.001
Government official	100 (17.24)	20.18±3.53		47.05±3.57		22.94±5.52	
Professional technical personnel (e.g., scientific research, engineering, agriculture, finance)	45 (7.76)	20.24±3.64		48.18±3.37		24.71±5.32	

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Higher education student	121 (20.86)	18.98±3.63		44.23±5.12	21.63±5.94	
Office staff	99 (17.07)	19.11±4.50		46.90±4.01	22.92±5.72	
Worker	51 (8.79)	18.82±4.18		45.88±4.14	24.47±4.67	
Self-employed	70 (12.07)	18.74±4.75		46.49±4.65	24.11±5.47	
Other	94 (16.21)	19.64±4.03		16.61±4.47	24.73±5.65	
Marital status			0.046			0.011
Single	233 (40.17)	19.29±3.83		45.43±4.79	22.62±5.91	
Other	347 (59.83)	19.43±4.19		46.85±4.13	23.87±5.45	
Children			0.017			0.005
No children	240 (41.38)	19.15±4.09		45.31±4.98	22.52±6.00	
Have children	340 (58.62)	19.53±4.02		46.96±3.91	23.96±5.35	
Type of blood donation this time			<0.001			0.004
Whole blood	489 (84.31)	19.06±4.23		46.13±4.55	23.03±5.85	
Blood component	91 (15.69)	21.04±2.23		47.09±3.81	25.15±4.15	
Number of blood donations			<0.001			<0.001
Once	158 (27.24)	18.16±4.61		45.27±4.96	22.13±6.16	
Twice	98 (16.9)	18.57±4.41		45.39±4.74	22.62±6.02	
3-4 times	93 (16.03)	19.34±3.81		46.40±4.06	23.43±5.44	
5-10 times	76 (13.1)	19.53±3.73		46.97±3.82	23.03±5.57	
≥11 times	155 (26.72)	21.05±2.74		47.47±3.90	25.23±4.58	

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Table 2. Knowledge distribution

	n (%)		
	Very familiar	Heard of it	Not clear
1. The country advocates that healthy citizens aged 18 to 55 voluntarily donate blood.	378 (65.47)	187 (32.24)	15 (2.59)
2. The interval between whole blood donations should be no less than 6 months. The interval for platelet donations should be no less than 2 weeks and no more than 24 times per year.	378 (65.47)	172 (29.66)	30 (5.17)
3. The usual amount of whole blood donated at one time is 200 milliliters, and it should not exceed 400 milliliters.	468 (80.69)	96 (16.55)	16 (2.76)
4. Vigorous exercise is not allowed after donating blood.	480 (82.76)	87 (15)	13 (2.24)
5. One should get adequate rest, eat light meals, and avoid fasting before donating blood.	489 (84.31)	78 (13.45)	13 (2.24)
6. A health check and blood test are required before donating blood.	489 (84.31)	81 (13.97)	10 (1.72)
7. Voluntary blood donation refers to the act of citizens donating their blood voluntarily without compensation.	506 (87.24)	61 (10.52)	13 (2.24)
8. A blood station is an institution that collects and provides blood for clinical use and is a non-profit organization.	488 (84.14)	75 (12.93)	17 (2.93)
9. Voluntary blood donors and their relatives can enjoy blood use discounts.	427 (73.62)	141 (24.31)	12 (2.07)
10. In most cases, blood donation is safe, but occasionally, some individuals may experience reactions.	429 (73.97)	135 (23.28)	16 (2.76)
11. People with blood-borne infectious diseases are not allowed to donate blood.	489 (84.31)	80 (13.79)	11 (1.9)

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Table 3. Attitude distribution

	n (%)				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. I believe that donating blood does not harm health and only requires a little courage.	362 (62.41)	195 (33.62)	7 (1.21)	14 (2.41)	2 (0.34)
2. I believe that donating blood can save lives and improve others' health.	433 (74.66)	144 (24.83)	2 (0.34)		1 (0.17)
3. I believe that blood donations should be made when people are in good health.	447 (77.07)	128 (22.07)	5 (0.86)		
4. I believe that blood donations should not be expected to be returned.	351 (60.52)	157 (27.07)	47 (8.10)	22 (3.79)	3 (0.52)
5. I believe blood stations should educate people about blood donation and promote it.	384 (66.21)	173 (29.83)	21 (3.62)	1 (0.17)	1 (0.17)
6. I am very satisfied with the blood donation services provided by the blood station.	421 (72.59)	151 (26.03)	6 (1.03)	2 (0.34)	
7. I believe that improving the skills and attitudes of blood station staff will make me more willing to donate blood again.	403 (69.48)	160 (27.59)	14 (2.41)	1 (0.17)	2 (0.34)
8. I believe that the informatization of voluntary blood donation (online appointment, online form filling, electronic blood donation certificate, and online blood reimbursement function) makes blood donation more convenient.	426 (73.45)	143 (24.66)	9 (1.55)	1 (0.17)	1 (0.17)
9. I believe that convenient blood use discount measures would make me more willing to donate blood.	414 (71.38)	150 (25.86)	13 (2.24)	3 (0.52)	
10. My family supports my blood donation.	343 (59.14)	173 (29.83)	34 (5.86)	25 (4.31)	5 (0.86)

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Table 4. Practice distribution

	N (%)				
	Always	Often	Sometimes	Rarely	Never
1. To ensure the quality of my blood donation, I will actively exercise.	243 (41.9)	196 (33.79)	80 (13.79)	56 (9.66)	5 (0.86)
2. I will educate my friends and family about the benefits and significance of blood donation.	233 (40.17)	151 (26.03)	112 (19.31)	70 (12.07)	14 (2.41)
3. I will encourage people around me to donate blood.	223 (38.45)	143 (24.66)	107 (18.45)	86 (14.83)	21 (3.62)
4. I will make an appointment online to donate blood.	222 (38.28)	111 (19.14)	95 (16.38)	90 (15.52)	62 (10.69)
5. I will take the initiative to learn about blood donation.	233 (40.17)	144 (24.83)	107 (18.45)	82 (14.14)	14 (2.41)
6. If there is a blood shortage at the blood station, I will donate blood proactively.	299 (51.55)	137 (23.62)	94 (16.21)	41 (7.07)	9 (1.55)

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Table 5. Correlation Analysis

	Knowledge	Attitudes	Practices
Knowledge	1		
Attitudes	0.580 (P<0.001)	1	
Practices	0.494 (P<0.001)	0.618 (P<0.001)	

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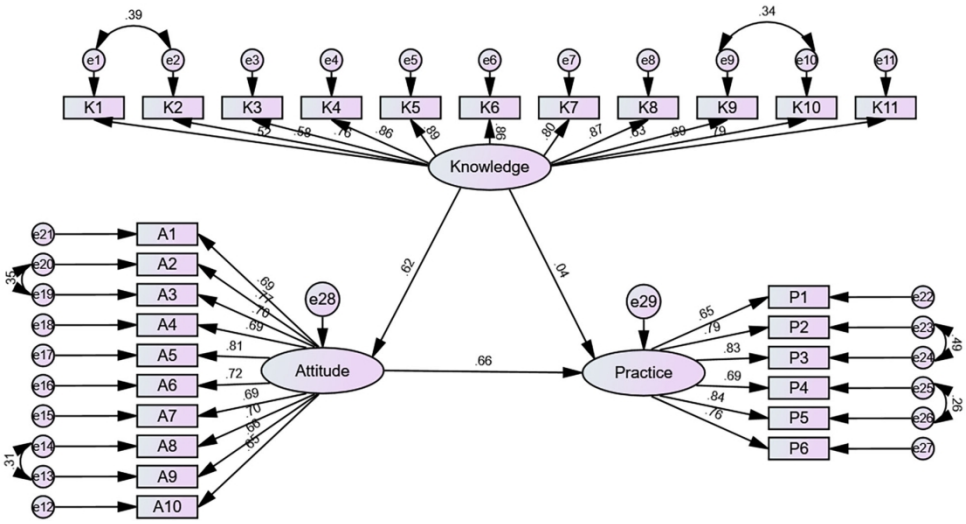

Figure 1. Structural equation modeling analysis

170x98mm (300 x 300 DPI)

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Supplementary Table S1. Structural equation modeling fit indexes

Indices	Ref.	Measured results
CMIN/DF	1-3 excellent, 3-5 good	3.766
RMSEA	<0.08 good	0.069
IFI	>0.8 good	0.919
TLI	>0.8 good	0.910
CFI	>0.8 good	0.919

CMIN/DF: minimum discrepancy function by degrees of freedom divided; RMSEA: root mean square error of approximation; IFI: incremental fit index; TLI: Tucker-Lewis index; CFI: comparative fit index.

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Supplementary Table S2. Structural equation modeling effects

Model paths	Standardized total effects		Standardized direct effects		Standardized indirect effects	
	β (95%CI)	P	β (95%CI)	P	β (95%CI)	P
Knowledge→Attitudes	0.622 (0.539-0.704)	0.007	0.622 (0.539-0.704)	0.007		
Knowledge→Practice	0.455 (0.358-0.531)	0.015	0.044 (-0.085-0.140)	0.508	0.411 (0.329-0.536)	0.005
Attitudes→Practice	0.661 (0.554-0.761)	0.006	0.661 (0.554-0.761)	0.006		

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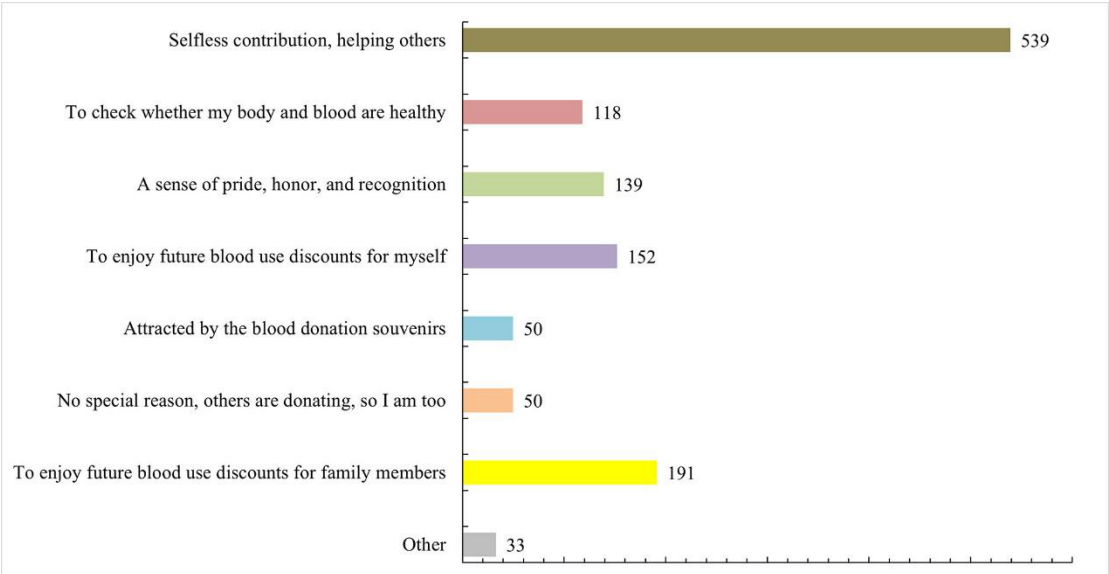

Supplementary Figure S1. Main reasons for donating blood this time

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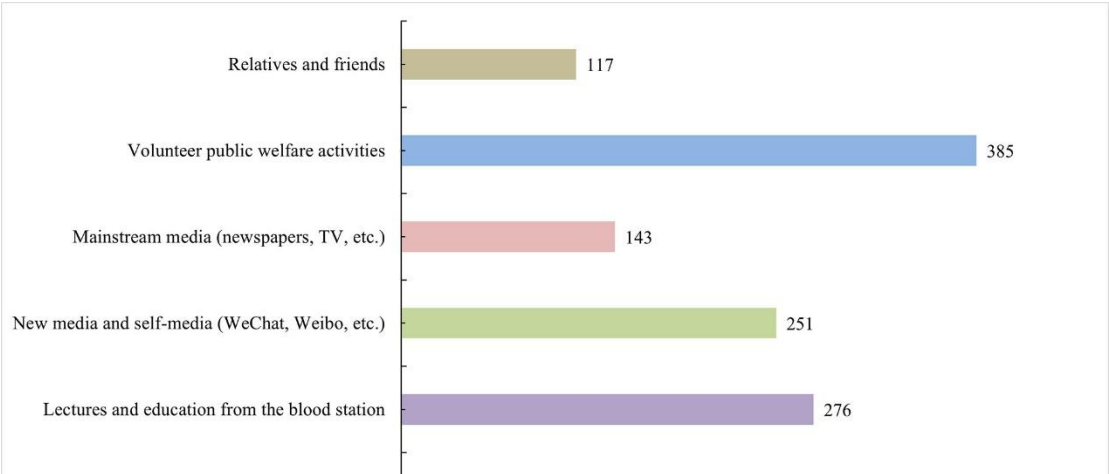

Supplementary Figure S2. Source of information about blood donation

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Questionnaire

Dear Blood Donor,

This study aims to understand the knowledge, attitudes, and practices of blood donors in the Zhejiang region to provide a basis for formulating scientific early intervention strategies. If you voluntarily agree to participate in this study, please refer to the following instructions.

1. Please fill in according to your actual situation; there are no right or wrong answers. Submit the completed questionnaire promptly.

2. This study is a simple survey and will not cause any harm to your physical or mental health. Any private information, such as gender and age, will be strictly confidential, so please feel assured while filling it out.

Finally, we sincerely thank you for taking the time out of your busy schedule to support our research!

□I acknowledge and agree that the collected data will be used for scientific research.

Signature for Informed Consent:

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Participation Date: year month day

Part One Basic Information

1. Your gender:	a. male b. female
2. Your age: _____ years old	
3. Your ethnicity: _____ (multiple choice)	
4. Your height: _____ cm	
5. Your weight: _____ kg	
6. Place of residence:	a. rural b. urban c. suburban

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7. Are you a registered resident of Shaoxing City:	a. yes b. no
8. Education level:	a. primary school or below b. middle school c. high school/technical secondary school d. associate degree/Bachler's degree e. master's degree or above
9. Occupation:	a. government official b. Professional technical personnel (e.g., scientific research, engineering, agriculture, finance) c. higher education student d. medical staff e. teacher

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	f. office staff g. worker h. farmer i. active military personnel j. self-employed k. other
10. Marital status:	a. single b. married c. divorced d. widowed
11. Childbearing status:	a. no children b. have children
12. Your main reasons for donating blood this time: (multiple	a. Selfless contribution, helping others b. To check whether my body and blood are healthy

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choices)	c. A sense of pride, honor, and recognition d. To enjoy future blood use discounts for myself e. Attracted by the blood donation souvenirs f. No special reason, others are donating, so I am too g. To enjoy future blood use discounts for family members h. Other
13. The type of blood donation this time:	a. Whole blood b. Component blood
14. Number of times you have donated blood:	a. Once b. Twice c. 3-4 times d. 5-10 times e. 11 times or above
15. Where do you mainly get information about blood donation:	a. Medical-related books and materials b. Lectures and education from the blood station c. New media and self-media (WeChat, Weibo, etc.) d. Mainstream media (newspapers, TV, etc.) e. Volunteer public welfare activities f. Relatives and friends

Part Two Knowledge of Blood Donation

1. The country advocates that healthy citizens aged 18 to 55 voluntarily donate blood.	a. very familiar b. heard of it c. not clear

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2. The interval between whole blood donations should be no less than 6 months. The interval for platelet donations should be no less than 2 weeks and no more than 24 times per year.	a. very familiar b. heard of it c. not clear
3. The usual amount of whole blood donated at one time is 200 milliliters, and it should not exceed 400 milliliters.	a. very familiar b. heard of it c. not clear
4. Vigorous exercise is not allowed after donating blood.	a. very familiar b. heard of it c. not clear
5. One should get adequate rest, eat light meals, and avoid fasting before donating blood.	a. very familiar b. heard of it c. not clear
6. A health check and blood test are required before donating blood.	a. very familiar b. heard of it c. not clear
7. Voluntary blood donation refers to the act of citizens donating their blood voluntarily without compensation.	a. very familiar b. heard of it c. not clear
8. A blood station is an institution that collects and provides blood for clinical use and is a non-profit organization.	a. very b. heard of c. not clear

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	familiar it
9. Voluntary blood donors and their relatives can enjoy blood use discounts.	a. very familiar b. heard of it c. not clear
10. In most cases, blood donation is safe, but occasionally some individuals may experience reactions.	a. very familiar b. heard of it c. not clear
11. People with blood-borne infectious diseases are not allowed to donate blood.	a. very familiar b. heard of it c. not clear
12. 10+10=30.	a. true b. false

Part Three Attitudes Towards Blood Donation

1. I believe that donating blood does not harm health and only requires a little courage.	a. strongly agree	b. agree	c. neutral	d. disagree	E strongly disagree
2. I believe that donating blood can save lives and improve others' health.	a. strongly agree	b. agree	c. neutral	d. disagree	E strongly disagree

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3.	**I believe that blood donation should be done when in good health.**	a. agree	strongly	b. agree	c. neutral	d. disagree	E disagree	strongly
4.	**I believe that blood donation should not expect any return.**	a. agree	strongly	b. agree	c. neutral	d. disagree	E disagree	strongly
5.	**I believe blood stations should conduct education and promotion about blood donation.**	a. agree	strongly	b. agree	c. neutral	d. disagree	E disagree	strongly
6.	**I am very satisfied with the blood donation services provided by the blood station.**	a. agree	strongly	b. agree	c. neutral	d. disagree	E disagree	strongly
7.	**I believe that improving the skills and attitudes of blood station staff will make me more willing to donate blood again.**	a. agree	strongly	b. agree	c. neutral	d. disagree	E disagree	strongly
8.	**I believe that informatization of voluntary blood donation (online appointment, online form filling, electronic blood donation certificate, and online blood reimbursement function) makes blood donation more convenient.**	a. agree	strongly	b. agree	c. neutral	d. disagree	E disagree	strongly
9.	**I believe that convenient blood use discount measures would make me more willing to donate blood.**	a.	strongly	b. agree	c. neutral	d. disagree	E	strongly

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	agree				disagree	
10. My family supports my blood donation.	a. strongly agree	b. agree	c. neutral	d. disagree	E strongly disagree	

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Part Four Blood Donation Practices

Frequency Criteria： Occurrences of 8 or more out of 10 times are considered "Always," 5-7 times as "Often," 3-4 times as "Sometimes," 1-2 times as "Rarely," and 0 times as "Never."

1. To ensure the quality of my blood donation, I will actively exercise.	a. always	b. often	c. sometimes	d. rarely	e. never
2. I will educate my friends and family about the benefits and significance of blood donation.	a. always	b. often	c. sometimes	d. rarely	e. never
3. I will encourage people around me to donate blood.	a. always	b. often	c. sometimes	d. rarely	e. never
4. I will make an appointment online to donate blood.	a. always	b. often	c. sometimes	d. rarely	e. never
5. I will take the initiative to learn about blood donation.	a. always	b. often	c. sometimes	d. rarely	e. never

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6. If there is a blood shortage at the blood station, I will donate blood proactively.	a. always b. often c. sometimes d. rarely e. never

Part Five Do You Have Any Opinions or Suggestions About Voluntary Blood Donation?

Please fill in:

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Knowledge, attitudes, and practices toward blood donation among donors: A cross-sectional study in Shaoxing, Zhejiang, China

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Knowledge, attitudes, and practices toward blood donation among donors: A cross-sectional study in Shaoxing, Zhejiang, China

Running title: KAP of blood donors

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ABSTRACT

Objective: To evaluate the knowledge, attitudes, and practices (KAP) toward blood donation among blood donors.

Design: A cross-sectional study was conducted.

Setting: The study surveyed voluntary blood donors in Shaoxing, Zhejiang.

Participants: A total of 580 voluntary blood donors participated in the survey between May 2024 and June 2024.

Interventions: An investigator-designed questionnaire was administered to collect demographic data and assess participants' KAP regarding blood donation.

Outcome Measures: The outcome measures included the knowledge, attitude, and practice scores of blood donors.

Results: Analysis revealed a mean knowledge score of 19.37 ± 4.05 (possible range: 0-22), an attitude score of 46.28 ± 4.45 (possible range: 10-50), and a practice score of 23.37 ± 5.67 (possible range: 6-30). Knowledge scores correlated positively with attitude ($r = 0.580$, $P < 0.001$) and practice scores ($r = 0.494$, $P < 0.001$). Furthermore, attitude scores showed a strong correlation with practice scores ($r = 0.618$, $P < 0.001$). Structural equation modeling indicated that knowledge directly influenced attitudes ($\beta = 0.622$, 95% CI: 0.539-0.704, $P = 0.007$) and had an indirect influence on practices ($\beta = 0.411$, 95% CI: 0.329-0.536, $P = 0.005$). Attitudes directly influenced practices ($\beta = 0.661$, 95% CI: 0.554-0.761, $P = 0.006$).

Conclusions: Blood donors exhibited good knowledge and positive attitudes, but their practices were suboptimal. These findings highlight the need for targeted interventions to enhance participation in blood donation.

Keywords: blood donation; blood donors; health knowledge, attitudes, practices; cross-sectional study; China.

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Strengths and limitations of this study

- The study involved 580 voluntary blood donors, providing a robust dataset that enhances the reliability and generalizability of the findings.
- The study's cross-sectional design limits the ability to establish causality between knowledge, attitudes, and practices regarding blood donation.
- Relying on self-reported questionnaires may introduce biases, affecting the accuracy of the knowledge, attitudes, and practices reported by participants.

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INTRODUCTION

Blood donation is paramount in global healthcare, with over 100 million blood units contributed annually. The availability of blood units is crucial for patients undergoing surgery, coping with trauma, managing chronic illnesses, and battling cancer. This essential procedure is a lifeline for many patients, sustaining and saving lives [1]. The two primary uses of blood units are for anemia correction and acute blood loss [1]. Blood donation is essential for maintaining blood banks, and declining donation rates can compromise the proper management of patients with trauma, those undergoing major surgeries, and patients with transfusion-dependent conditions (e.g., transfusion-dependent thalassemia) [2, 3]. The World Health Organization (WHO) estimated that at least 1% of a nation's population should voluntarily donate blood to meet the basic requirement for blood and its products [4]. The high prevalence of chronic infections in some regions (e.g., hepatitis B and C) [5, 6] and the use of certain medications can also limit blood donations [7, 8]. The donor must also meet fitness criteria (e.g., minimum allowable hemoglobin level, a normal body temperature) and wait for the proper interval to replenish iron stores [9, 10]. Furthermore, offering incentives for blood donation appears economically inefficient [2].

In addition to medical contraindications and regional incentives, individual knowledge and motivation play key roles in blood donation. Blood donation is a voluntary process, and while publicity campaigns can influence donation rates, a person's knowledge of the importance of blood donation and their attitudes toward it are major factors influencing their practice of donating blood. Knowledge, attitude, and practice (KAP) surveys can be used to identify gaps, misunderstandings, and misconceptions that can constitute barriers to the optimal performance of a specific set of actions in a specific population [11-13]. Previous KAP studies explored the domain of voluntary blood donation, including the reasons for donating blood or not, sources of knowledge, motivating and demotivating factors for voluntary blood donation, and the

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impact of peer structure on potential donors, among others [14-25]. One previous study on college students in Wuhan (China) identified factors associated with their KAP toward blood donation [26]. Another study in Students in Sichuan showed that the KAP of donors was higher than that of non-donors [27]. Still, those factors can vary widely among different regions of the world, even within a country, due to differences in economic conditions, education, healthcare systems, culture, and various socioeconomic factors. China is a large country with vast disparities in socioeconomic statuses among different provinces. Therefore, it is essential to perform KAP studies in specific areas to design interventions specific to those areas.

Therefore, the present study aimed to evaluate the KAP toward blood donation among blood donors in Zhejiang province, located in the economically developed southeastern region of China. The results could provide useful insights for blood donation management and education.

METHODS

Study design and participants

This cross-sectional study enrolled voluntary blood donors at the Shaoxing Central Blood Station in Shaoxing, Zhejiang Province, China, between May 2024 and June 2024. The study was approved by the Ethics Committee of Shaoxing Central Blood Station (approval no. (2024) 1). Written informed consent was obtained from all participants.

The inclusion criteria were: 1) voluntary blood donors, 2) willingness to participate in the study, and 3) age >18 years. Participants aged over 60 years were excluded.

Questionnaire design

The initial questionnaire draft was designed based on the literature [14-23]. The questionnaire was then revised based on feedback from two experts in the Zhejiang province blood donation system. The questionnaire underwent a preliminary survey and reliability testing, achieving a

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reliability score of 0.883. The participants were asked to indicate any question, word, or item that was difficult to understand to ensure face validity.

The final questionnaire was in Chinese and consisted of four sections: demographic data, knowledge dimension, attitude dimension, and practice dimension. Basic demographic information included gender, age, body mass index (BMI), local registered residence, place of residence, education, occupation, marital status, childbearing status, type of blood donation, number of times donated, main reasons for donating blood, and information sources about blood donation. The knowledge dimension included 11 items, with responses scored as "very knowledgeable" = 2 points, "heard of it" = 1 point, and "not clear" = 0 points, resulting in a total score range of 0-22 points. The attitude dimension contained 10 questions scored using a five-point Likert scale, with positive statements scored from "strongly agree" = 5 points to "strongly disagree" = 1 point, resulting in a total score range of 10-50 points. The practice dimension consisted of seven questions, with the first question analyzed descriptively but not scored, and questions 2-7 scored from "never" = 1 point to "always" = 5 points, resulting in a total score range of 6-30 points. Scores in each dimension exceeding 80% of the total score were considered sufficient knowledge, favorable attitude, and proactive practice [13, 28].

Questionnaire distribution

The questionnaire was uploaded to the Questionnaire Star platform, and a QR code was generated. The QR code was distributed through the Shaoxing Central Blood Station, various blood donation centers (Lingchao Philanthropy Blood Donation Center, Shaoxing Love Blood Donation Center, Keqiao Love Blood Donation Center), WeChat groups (Shaoxing Central Blood Station "Board Friends Home" group, Shaoxing College Platelet Alliance), the researcher's WeChat Moments, and mobile blood donation vehicles. Participants completed the questionnaire independently. To ensure data integrity, each IP address was limited to submitting one response, and all questions were mandatory for submission.

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A trap question ("10+10=30") was included, and questionnaires with "true" selected for this question were considered invalid. Questionnaires with obvious errors (e.g., impossible age) or filled in an obvious pattern (e.g., all first choices) were excluded. All questionnaires were filled out anonymously.

Sample Size

A single population proportion formula, $n=[(Z_{\alpha/2})^2*P(1-P)]/d^2$, was used to calculate the sample size. Since no prior KAP scores on blood donation among Chinese blood donors were available, the sample size for this study was calculated based on an expected proportion of 50%, with a confidence level of 95% and a margin of error of 5%, requiring a sample size of 384 individuals. Considering a 20% drop-out rate, a total of 480 individuals were required.

Statistical analysis

Statistical analysis was performed using SPSS 27.0 and AMOS 26.0 (IBM, Armonk, NY, USA). Continuous variables were expressed as means ± standard deviations and analyzed using the Mann-Whitney U-test or Kruskal-Wallis H-test. Categorical variables were expressed as n (%). Spearman correlation analysis was used to assess the relationship between KAP dimensions. A structural equation modeling (SEM) analysis was conducted to test the following hypotheses: (H1) knowledge directly affects attitude, (H2) knowledge directly affects practice, and (H3) knowledge indirectly affects practice through attitude. The model fit indices for SEM were evaluated against the following thresholds: minimum discrepancy function by degrees of freedom divided (CMIN/DF); root mean square error of approximation (RMSEA); standardized root mean square residual (SRMR); Tucker–Lewis index (TLI); and comparative fit index (CFI). P-values <0.05 were considered statistically significant.

Patient and public involvement statement

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RESULTS

Characteristics of the participants

The study enrolled 580 participants with valid questionnaires. Genders were approximately equally represented, with 48.45% male and 51.55% female. The majority of participants were over 40 years old (34.83%), had a BMI <24 kg/m^2 (51.21%), were registered residents of Shaoxing City (62.41%), lived in urban areas (58.79%), had an associate degree education or above (70.34%), were not single (59.83%), had children (58.62%), were donating whole blood (84.31%), and had donated more than once (72.76%) (Table 1). Supplementary Figure S1 shows that the main reasons for donating blood (at the time of the survey) were selfless contribution and helping others. Supplementary Figure S2 shows that the main source of information about blood donation was volunteer public welfare activities.

Knowledge

The mean knowledge score was 19.37±4.05 (possible range: 0-22) (Table 1). The knowledge scores were significantly associated with age (P=0.003), city registration (P<0.001), education (P=0.007), occupation (P<0.001), marital status (P=0.046), children (P=0.017), type of blood donation (P<0.001), and the number of donations (P<0.001) (Table 1). The two knowledge items with the lowest scores (yet still above 80%) were related to the target population for blood donation (K1) and the optimal interval between donations (K2) (Table 2).

Attitudes

The mean attitude score was 46.28±4.45 (possible range: 10-50) (Table 1). The attitudes scores were significantly associated with age (P<0.001), BMI (P=0.044), education (P=0.023), occupation (P<0.001), marital status (P<0.001), children (P<0.001), and number of blood donations (P<0.001) (Table 1). All attitude items showed high scores. The lowest score was observed regarding the expectation of receiving some form of return after blood donation (A4) (Table 3).

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Practice

The mean practice score was 23.37±5.67 (possible range: 6-30) (Table 1). The practice scores were significantly associated with gender (P=0.016), age (P<0.001), BMI (P=0.044), education (P=0.023), occupation (P<0.001), marital status (P=0.011), children (P=0.005), type of blood donation (P=0.004), and the number of blood donations (P<0.001) (Table 1). The lowest practice scores were observed regarding making an appointment online for blood donation (P4), encouraging others to donate blood (P3), propagating knowledge about the benefits and significance of blood donation (P2), and taking the initiative to learn more about blood donation (P5) (Table 4).

Correlations

As shown in Table 5, knowledge scores were correlated to the attitude (r=0.580, P<0.001) and practice (r=0.494, P<0.001) scores. The attitude scores were correlated to the practice scores (r=0.618, P<0.001).

SEM analyses

Supplementary Table S1 shows that the fit of the model was good. The mediation analysis showed that knowledge had a direct influence on attitudes (β=0.622, 95% CI: 0.539-0.704, P=0.007) but only an indirect influence on practice (β=0.411, 95% CI: 0.329-0.536, P=0.005). Attitudes had a direct influence on practice (β=0.661, 95% CI: 0.554-0.761, P=0.006) (Figure 1 and Supplementary Table S2).

DISCUSSION

This study suggests that blood donors had good knowledge and positive attitudes but suboptimal practices toward blood donation. Such data could be used to design interventions to increase participation in blood donation in Zhejiang.

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In the present study, the participants had good knowledge and positive attitudes. Such results are not surprising since the study was performed on blood donors, and the majority had donated blood more than once. A study in 16 Arabic countries showed that university students had poor knowledge and low donation rates but positive attitudes toward blood donation [29], while studies in India [30] and Saudi Arabia [31] showed higher knowledge levels. Knowledge of the societal benefits of blood donation and positive attitudes are essential for blood donors since blood donation is voluntary [2]. Even medical students were reported to have poor knowledge about blood donation yet maintain positive attitudes [15, 16, 18]. It has been suggested that regular blood donation camps should be organized to spread the knowledge about blood donation and motivate eventual new donors [17].

In the present study, the practice score was below (but near) the 80% threshold, indicating that some improvements might be necessary to optimize blood donation in Zhejiang. Although contraindications for blood donation are screened in the donation process, some knowledge of them can help promote the right knowledge in one's surroundings. Again, since the study was performed on regular blood donors, those with contraindications were screened out in the past. The slightly suboptimal practice could also be related to time constraints associated with blood donation (e.g., commuting to a donation center, taking time for the whole blood donation process, and waiting after blood donation to avoid side effects like dizziness and falls). Of course, it is expected that blood donors will have higher KAP scores than non-donors or the general population. Indeed, poor knowledge and practice of blood donation have been observed in the general population in several areas [24, 25]. Previous studies showed that the main reasons for not participating in blood donation were the fear of needles, the sight of blood, concerns about safety and adverse effects, disapproval from peers, and never having been asked for [15, 16, 20]. In 16 Arabic countries, the main barriers to blood donation were: not being asked (37%), ineligibility (33%), fear of pain or infection (18%), concerns about negative

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health effects (18%), difficulty accessing donation centers (15%), and medical mistrust (14%) [29]. In the present study, the main motivation of blood donors for blood donation was selfless action that helps others. Future studies should be performed on the general population and should compare blood donors and non-donors. A better grasp of the factors associated with poor KAP toward blood donations and of the actual barriers to blood donation could be identified. Of note, many donors donate blood a single time without becoming regular donors [31-33]. That aspect should also be investigated to improve the regular donation rate.

In the present study, the majority of the participants were older, well-educated professionals, probably biasing the results toward a better KAP toward blood donation. In Wuhan (China), Ma et al. [26] showed that blood donation among college and university students was associated with more favorable sociodemographic characteristics and health status, higher knowledge about blood donation, and a more positive attitude towards blood donation. Eltewacy et al. [29] reported that among university students in 16 Arabic countries, private and international university enrollment was associated with higher knowledge, while non-health science college students had lower knowledge, and participants > 20 years old were more likely to donate while being female, having congenital or chronic diseases, and low knowledge of blood donation were associated with poor practice of blood donation. Socioeconomic status is associated with healthcare literacy [34]. Age was also reported to be associated with better blood donation practice [30, 35]. The female gender was associated with lower practice scores in the present study, as previously reported [29]. The lower practice in females could be related to cultural taboos about women donating blood [36]. Lower blood iron levels during menstruation [37] can also influence the eligibility for blood donation, complicating the donation process due to attention to donation timing. In addition, the weight eligibility criteria and side effects such as dizziness can be barriers to women donating blood despite higher altruism than in men [38]. Indeed, in the present study, a lower BMI was associated with lower

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practice scores. In the present study, since all participants were blood donors with a favorable socioeconomic status, it is possible that they were more willing to participate in blood donation. Again, a future study should include both blood donors and non-donors.

In the present study, knowledge influenced attitudes, which influenced practice. It is consistent with the KAP theory, stipulating that knowledge is the basis for knowledge while attitudes are the force driving practice [11, 12]. On the other hand, knowledge did not directly influence practice. Hence, those results could suggest that the key to improving practice would be to directly motivate individuals to participate in blood donation, facilitate the process, and increase the opportunities for blood donation.

The present study had limitations. The participants were from a single area, limiting the generalizability of the results. The questionnaire was designed by the investigators based on local practices, culture, and policies, limiting the generalizability of the results and the exportability of the questionnaire. The study was cross-sectional, preventing the analysis of causality. Still, a SEM analysis was performed as a surrogate of causality, but the results must be taken cautiously because causality is statistically inferred rather than observed [39-41]. The QR code was distributed publicly, and it was impossible to determine how many single people saw and scanned the code, preventing the calculation of a response rate. Finally, the social desirability bias can affect the results. Since the knowledge scores were high, there is a possibility that some participants might have answered what they knew they had to think or do instead of what they were really thinking or doing [42, 43]. Finally, this study enrolled blood donors, and the KAP status of the general population remains unknown.

In conclusion, blood donors had good knowledge and positive attitudes but suboptimal practices toward blood donation. These findings could inform the development of interventions aimed at increasing blood donation participation.

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Declarations

Ethics approval and consent to participate

All procedures were performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. The study was approved by the Ethics Committee of Shaoxing Central Blood Station (approval no. (2024) 1). Written informed consent was obtained from all participants. The study was carried out in accordance with the applicable guidelines and regulations.

Consent for publication

Not Applicable

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Competing interests

None

Funding

None

Authors' contributions

Lingling Jiang, Xiaolei Zhong, and Shoubing Zhu carried out the studies, participated in collecting data, and drafted the manuscript. Qichao Mao and Fang Yuan performed the statistical analysis and participated in its design. Nuo Li and Haiyan Luo participated in the acquisition, analysis, or interpretation of data and drafted the manuscript. All authors read and approved the final manuscript. The guarantor is Lingling Jiang

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Figure Legends

Figure 1. Structural equation modeling analysis

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Table 1. Characteristics of the participants

Variables	n (%)	Knowledge	P	Attitudes	P	Practices	P
Total score	**n=580**	19.37±4.05		46.28±4.45		23.37±5.67	
Gender			0.250		0.717		0.016
Male	281 (48.45)	19.02±4.49		46.05±4.84		23.92±5.66	
Female	299 (51.55)	19.70±3.57		46.49±4.05		22.85±5.64	
Age (years)			0.003		<0.001		<0.001
18-29	214 (36.9)	19.36±3.78		45.40±4.84		22.57±6.02	
30-39	164 (28.28)	18.92±4.45		46.39±4.42		22.79±6.02	
≥40	202 (34.83)	19.75±3.97		47.13±3.86		24.68±4.69	
Body mass index (kg/m^2)			0.164		0.510		0.044
<24	297 (51.21)	19.51±3.75		46.21±4.42		23.00±5.63	
24-27.9	171 (29.48)	19.18±4.44		46.28±4.62		23.64±5.23	
28-34.5	61 (10.52)	19.54±4.53		46.90±4.21		25.10±5.32	
≥35	51 (8.79)	19.02±3.80		45.96±4.45		22.51±7.19	
Registered resident of Shaoxing City			<0.001		0.084		0.186
Yes	362 (62.41)	19.65±4.06		46.69±4.26		23.62±5.55	
No	218 (37.59)	18.90±4.00		45.61±4.69		22.94±5.85	
Place of residence			0.238		0.126		0.476
Rural	175 (30.17)	19.03±4.20		46.08±4.62		23.33±5.63	
Urban	341 (58.79)	19.62±3.83		46.57±4.23		23.54±5.63	
Suburban	64 (11.03)	18.94±4.67		45.30±5.03		22.55±5.99	
Education level			0.007		0.009		0.023
Middle school and below	77 (13.28)	17.91±5.16		45.06±4.90		22.49±5.18	
High school/technical secondary school	95 (16.38)	19.76±3.81		46.95±4.32		24.60±5.36	
Associate degree and above	408 (70.34)	19.56±3.81		46.36±4.36		23.25±5.79	
Occupation			<0.001		<0.001		<0.001
Government official	100 (17.24)	20.18±3.53		47.05±3.57		22.94±5.52	
Professional technical personnel (e.g., scientific research, engineering, agriculture, finance)	45 (7.76)	20.24±3.64		48.18±3.37		24.71±5.32	

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Higher education student	121 (20.86)	18.98±3.63		44.23±5.12	21.63±5.94	
Office staff	99 (17.07)	19.11±4.50		46.90±4.01	22.92±5.72	
Worker	51 (8.79)	18.82±4.18		45.88±4.14	24.47±4.67	
Self-employed	70 (12.07)	18.74±4.75		46.49±4.65	24.11±5.47	
Other	94 (16.21)	19.64±4.03		16.61±4.47	24.73±5.65	
Marital status			0.046			0.011
Single	233 (40.17)	19.29±3.83		45.43±4.79	22.62±5.91	
Other	347 (59.83)	19.43±4.19		46.85±4.13	23.87±5.45	
Children			0.017			0.005
No children	240 (41.38)	19.15±4.09		45.31±4.98	22.52±6.00	
Have children	340 (58.62)	19.53±4.02		46.96±3.91	23.96±5.35	
Type of blood donation this time			<0.001			0.004
Whole blood	489 (84.31)	19.06±4.23		46.13±4.55	23.03±5.85	
Blood component	91 (15.69)	21.04±2.23		47.09±3.81	25.15±4.15	
Number of blood donations			<0.001			<0.001
Once	158 (27.24)	18.16±4.61		45.27±4.96	22.13±6.16	
Twice	98 (16.9)	18.57±4.41		45.39±4.74	22.62±6.02	
3-4 times	93 (16.03)	19.34±3.81		46.40±4.06	23.43±5.44	
5-10 times	76 (13.1)	19.53±3.73		46.97±3.82	23.03±5.57	
≥11 times	155 (26.72)	21.05±2.74		47.47±3.90	25.23±4.58	

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Table 2. Knowledge distribution

	n (%)		
	Very familiar	Heard of it	Not clear
1. The country advocates that healthy citizens aged 18 to 55 voluntarily donate blood.	378 (65.47)	187 (32.24)	15 (2.59)
2. The interval between whole blood donations should be no less than 6 months. The interval for platelet donations should be no less than 2 weeks and no more than 24 times per year.	378 (65.47)	172 (29.66)	30 (5.17)
3. The usual amount of whole blood donated at one time is 200 milliliters, and it should not exceed 400 milliliters.	468 (80.69)	96 (16.55)	16 (2.76)
4. Vigorous exercise is not allowed after donating blood.	480 (82.76)	87 (15)	13 (2.24)
5. One should get adequate rest, eat light meals, and avoid fasting before donating blood.	489 (84.31)	78 (13.45)	13 (2.24)
6. A health check and blood test are required before donating blood.	489 (84.31)	81 (13.97)	10 (1.72)
7. Voluntary blood donation refers to the act of citizens donating their blood voluntarily without compensation.	506 (87.24)	61 (10.52)	13 (2.24)
8. A blood station is an institution that collects and provides blood for clinical use and is a non-profit organization.	488 (84.14)	75 (12.93)	17 (2.93)
9. Voluntary blood donors and their relatives can enjoy blood use discounts.	427 (73.62)	141 (24.31)	12 (2.07)
10. In most cases, blood donation is safe, but occasionally, some individuals may experience reactions.	429 (73.97)	135 (23.28)	16 (2.76)
11. People with blood-borne infectious diseases are not allowed to donate blood.	489 (84.31)	80 (13.79)	11 (1.9)

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Table 3. Attitude distribution

	n (%)				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. I believe that donating blood does not harm health and only requires a little courage.	362 (62.41)	195 (33.62)	7 (1.21)	14 (2.41)	2 (0.34)
2. I believe that donating blood can save lives and improve others' health.	433 (74.66)	144 (24.83)	2 (0.34)		1 (0.17)
3. I believe that blood donations should be made when people are in good health.	447 (77.07)	128 (22.07)	5 (0.86)		
4. I believe that blood donations should not be expected to be returned.	351 (60.52)	157 (27.07)	47 (8.10)	22 (3.79)	3 (0.52)
5. I believe blood stations should educate people about blood donation and promote it.	384 (66.21)	173 (29.83)	21 (3.62)	1 (0.17)	1 (0.17)
6. I am very satisfied with the blood donation services provided by the blood station.	421 (72.59)	151 (26.03)	6 (1.03)	2 (0.34)	
7. I believe that improving the skills and attitudes of blood station staff will make me more willing to donate blood again.	403 (69.48)	160 (27.59)	14 (2.41)	1 (0.17)	2 (0.34)
8. I believe that the informatization of voluntary blood donation (online appointment, online form filling, electronic blood donation certificate, and online blood reimbursement function) makes blood donation more convenient.	426 (73.45)	143 (24.66)	9 (1.55)	1 (0.17)	1 (0.17)
9. I believe that convenient blood use discount measures would make me more willing to donate blood.	414 (71.38)	150 (25.86)	13 (2.24)	3 (0.52)	
10. My family supports my blood donation.	343 (59.14)	173 (29.83)	34 (5.86)	25 (4.31)	5 (0.86)

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Table 4. Practice distribution

	N (%)				
	Always	Often	Sometimes	Rarely	Never
1. To ensure the quality of my blood donation, I will actively exercise.	243 (41.9)	196 (33.79)	80 (13.79)	56 (9.66)	5 (0.86)
2. I will educate my friends and family about the benefits and significance of blood donation.	233 (40.17)	151 (26.03)	112 (19.31)	70 (12.07)	14 (2.41)
3. I will encourage people around me to donate blood.	223 (38.45)	143 (24.66)	107 (18.45)	86 (14.83)	21 (3.62)
4. I will make an appointment online to donate blood.	222 (38.28)	111 (19.14)	95 (16.38)	90 (15.52)	62 (10.69)
5. I will take the initiative to learn about blood donation.	233 (40.17)	144 (24.83)	107 (18.45)	82 (14.14)	14 (2.41)
6. If there is a blood shortage at the blood station, I will donate blood proactively.	299 (51.55)	137 (23.62)	94 (16.21)	41 (7.07)	9 (1.55)

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Table 5. Correlation Analysis

	Knowledge	Attitudes	Practices
Knowledge	1		
Attitudes	0.580 (P<0.001)	1	
Practices	0.494 (P<0.001)	0.618 (P<0.001)	1

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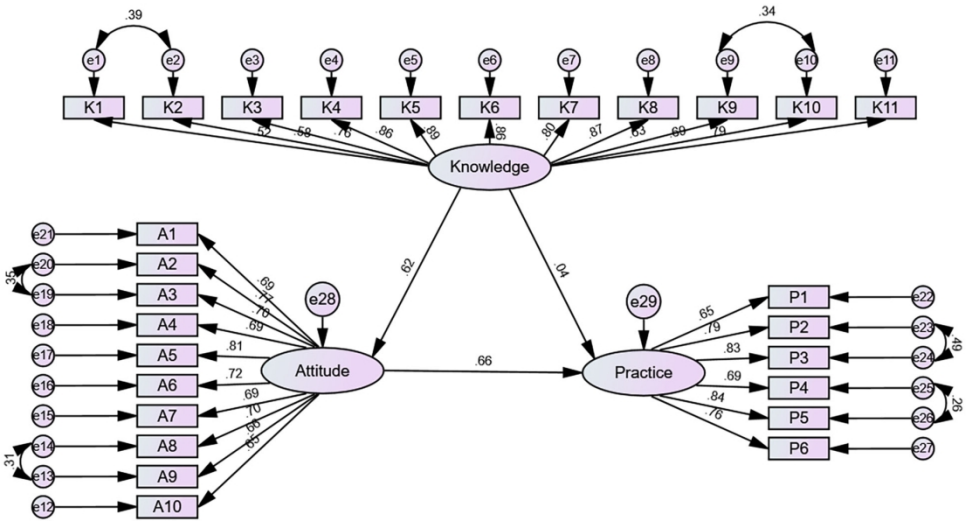

Figure 1. Structural equation modeling analysis

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Supplementary Table S1. Structural equation modeling fit indexes

Indices	Ref.	Measured results
CMIN/DF	1-3 excellent, 3-5 good	3.766
RMSEA	<0.08 good	0.069
IFI	>0.8 good	0.919
TLI	>0.8 good	0.910
CFI	>0.8 good	0.919

CMIN/DF: minimum discrepancy function by degrees of freedom divided; RMSEA: root mean square error of approximation; IFI: incremental fit index; TLI: Tucker-Lewis index; CFI: comparative fit index.

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Supplementary Table S2. Structural equation modeling effects

Model paths	Standardized total effects		Standardized direct effects		Standardized indirect effects	
	β (95%CI)	P	β (95%CI)	P	β (95%CI)	P
Knowledge→Attitudes	0.622 (0.539-0.704)	0.007	0.622 (0.539-0.704)	0.007		
Knowledge→Practice	0.455 (0.358-0.531)	0.015	0.044 (-0.085-0.140)	0.508	0.411 (0.329-0.536)	0.005
Attitudes→Practice	0.661 (0.554-0.761)	0.006	0.661 (0.554-0.761)	0.006		

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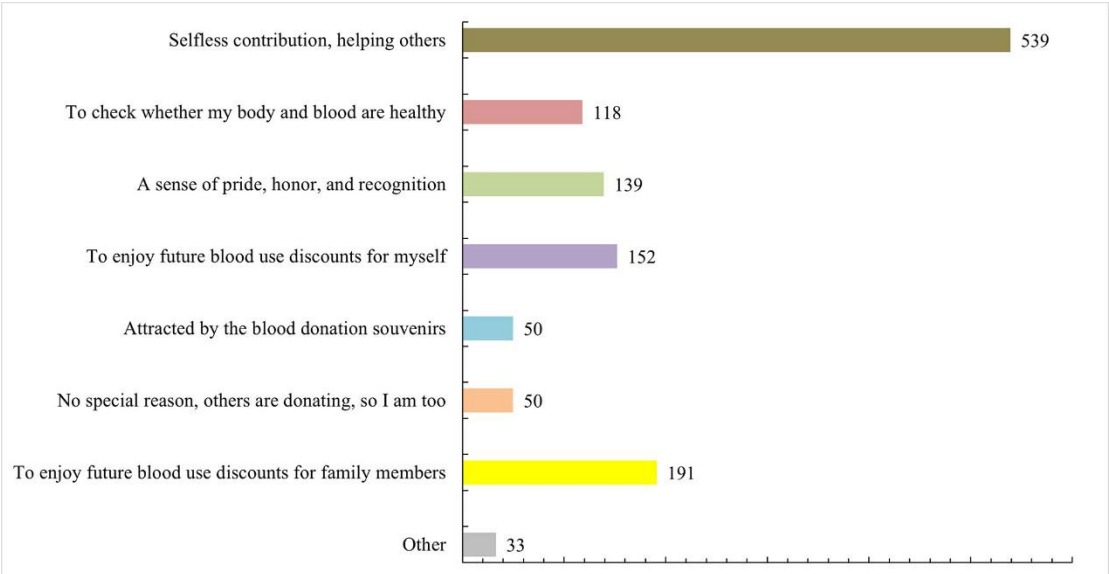

Supplementary Figure S1. Main reasons for donating blood this time

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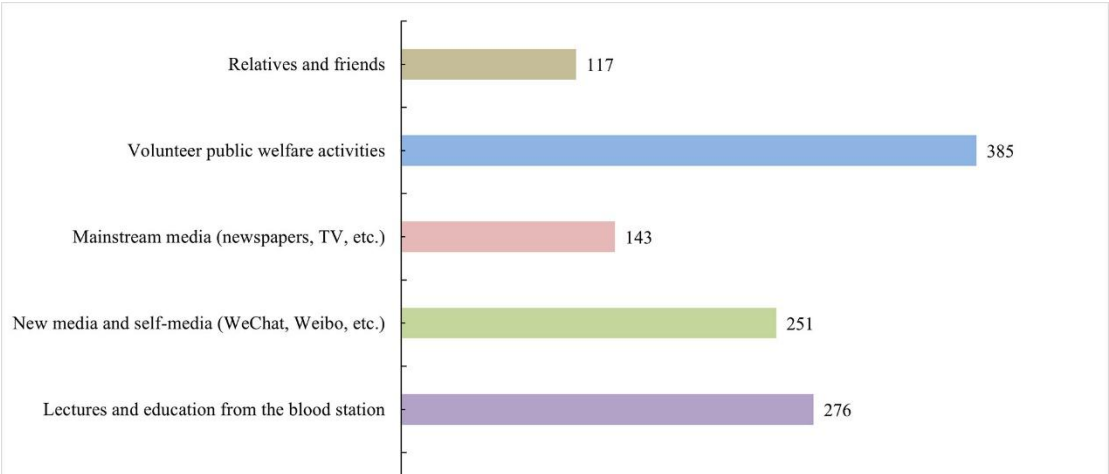

Supplementary Figure S2. Source of information about blood donation

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Questionnaire

Dear Blood Donor,

This study aims to understand the knowledge, attitudes, and practices of blood donors in the Zhejiang region to provide a basis for formulating scientific early intervention strategies. If you voluntarily agree to participate in this study, please refer to the following instructions.

1. Please fill in according to your actual situation; there are no right or wrong answers. Submit the completed questionnaire promptly.

2. This study is a simple survey and will not cause any harm to your physical or mental health. Any private information, such as gender and age, will be strictly confidential, so please feel assured while filling it out.

Finally, we sincerely thank you for taking the time out of your busy schedule to support our research!

□I acknowledge and agree that the collected data will be used for scientific research.

Signature for Informed Consent:

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Participation Date: year month day

Part One Basic Information

1. Your gender:	a. male b. female
2. Your age: _____ years old	
3. Your ethnicity: _____ (multiple choice)	
4. Your height: _____ cm	
5. Your weight: _____ kg	
6. Place of residence:	a. rural b. urban c. suburban

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7. Are you a registered resident of Shaoxing City:	a. yes b. no
8. Education level:	a. primary school or below b. middle school c. high school/technical secondary school d. associate degree/Bachler's degree e. master's degree or above
9. Occupation:	a. government official b. Professional technical personnel (e.g., scientific research, engineering, agriculture, finance) c. higher education student d. medical staff e. teacher

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	f. office staff g. worker h. farmer i. active military personnel j. self-employed k. other
10. Marital status:	a. single b. married c. divorced d. widowed
11. Childbearing status:	a. no children b. have children
12. Your main reasons for donating blood this time: (multiple	a. Selfless contribution, helping others b. To check whether my body and blood are healthy

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choices)	c. A sense of pride, honor, and recognition d. To enjoy future blood use discounts for myself e. Attracted by the blood donation souvenirs f. No special reason, others are donating, so I am too g. To enjoy future blood use discounts for family members h. Other
13. The type of blood donation this time:	a. Whole blood b. Component blood
14. Number of times you have donated blood:	a. Once b. Twice c. 3-4 times d. 5-10 times e. 11 times or above
15. Where do you mainly get information about blood donation:	a. Medical-related books and materials b. Lectures and education from the blood station c. New media and self-media (WeChat, Weibo, etc.) d. Mainstream media (newspapers, TV, etc.) e. Volunteer public welfare activities f. Relatives and friends

Part Two Knowledge of Blood Donation

1. The country advocates that healthy citizens aged 18 to 55 voluntarily donate blood.	a. very familiar b. heard of it c. not clear

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2. The interval between whole blood donations should be no less than 6 months. The interval for platelet donations should be no less than 2 weeks and no more than 24 times per year.	a. very familiar b. heard of it c. not clear
3. The usual amount of whole blood donated at one time is 200 milliliters, and it should not exceed 400 milliliters.	a. very familiar b. heard of it c. not clear
4. Vigorous exercise is not allowed after donating blood.	a. very familiar b. heard of it c. not clear
5. One should get adequate rest, eat light meals, and avoid fasting before donating blood.	a. very familiar b. heard of it c. not clear
6. A health check and blood test are required before donating blood.	a. very familiar b. heard of it c. not clear
7. Voluntary blood donation refers to the act of citizens donating their blood voluntarily without compensation.	a. very familiar b. heard of it c. not clear
8. A blood station is an institution that collects and provides blood for clinical use and is a non-profit organization.	a. very b. heard of c. not clear

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	familiar it
9. Voluntary blood donors and their relatives can enjoy blood use discounts.	a. very familiar b. heard of it c. not clear
10. In most cases, blood donation is safe, but occasionally some individuals may experience reactions.	a. very familiar b. heard of it c. not clear
11. People with blood-borne infectious diseases are not allowed to donate blood.	a. very familiar b. heard of it c. not clear
12. 10+10=30.	a. true b. false

Part Three Attitudes Towards Blood Donation

1. I believe that donating blood does not harm health and only requires a little courage.	a. strongly agree	b. agree	c. neutral	d. disagree	E strongly disagree
2. I believe that donating blood can save lives and improve others' health.	a. strongly agree	b. agree	c. neutral	d. disagree	E strongly disagree

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3.	**I believe that blood donation should be done when in good health.**	a. agree	strongly	b. agree	c. neutral	d. disagree	E disagree	strongly
4.	**I believe that blood donation should not expect any return.**	a. agree	strongly	b. agree	c. neutral	d. disagree	E disagree	strongly
5.	**I believe blood stations should conduct education and promotion about blood donation.**	a. agree	strongly	b. agree	c. neutral	d. disagree	E disagree	strongly
6.	**I am very satisfied with the blood donation services provided by the blood station.**	a. agree	strongly	b. agree	c. neutral	d. disagree	E disagree	strongly
7.	**I believe that improving the skills and attitudes of blood station staff will make me more willing to donate blood again.**	a. agree	strongly	b. agree	c. neutral	d. disagree	E disagree	strongly
8.	**I believe that informatization of voluntary blood donation (online appointment, online form filling, electronic blood donation certificate, and online blood reimbursement function) makes blood donation more convenient.**	a. agree	strongly	b. agree	c. neutral	d. disagree	E disagree	strongly
9.	**I believe that convenient blood use discount measures would make me more willing to donate blood.**	a.	strongly	b. agree	c. neutral	d. disagree	E	strongly

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	agree				disagree	
10. My family supports my blood donation.	a. strongly agree	b. agree	c. neutral	d. disagree	E strongly disagree	

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Part Four Blood Donation Practices

Frequency Criteria： Occurrences of 8 or more out of 10 times are considered "Always," 5-7 times as "Often," 3-4 times as "Sometimes," 1-2 times as "Rarely," and 0 times as "Never."

1. To ensure the quality of my blood donation, I will actively exercise.	a. always	b. often	c. sometimes	d. rarely	e. never
2. I will educate my friends and family about the benefits and significance of blood donation.	a. always	b. often	c. sometimes	d. rarely	e. never
3. I will encourage people around me to donate blood.	a. always	b. often	c. sometimes	d. rarely	e. never
4. I will make an appointment online to donate blood.	a. always	b. often	c. sometimes	d. rarely	e. never
5. I will take the initiative to learn about blood donation.	a. always	b. often	c. sometimes	d. rarely	e. never

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6. If there is a blood shortage at the blood station, I will donate blood proactively.	a. always b. often c. sometimes d. rarely e. never

Part Five Do You Have Any Opinions or Suggestions About Voluntary Blood Donation?

Please fill in:

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