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Systematic Review
A Systematic Review and Evidence Gap Analysis of Dietary and Biochemical Profiles of Blood Donors

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Abstract

Transfusion safety is a global priority and a major public health issue, particularly in Sub-Saharan Africa, where blood donation rates remain low. In 2016, approximately 118.5 million donations were recorded worldwide, of which only 5‰ came from African countries, compared to 31.5‰ in high-income countries. This disparity highlights the need to strengthen the promotion of blood donation by taking greater account of donor health, a determining factor in the availability of this vital fluid. The quality of nutrition plays an essential role in maintaining the health of donors and influences their ability to give blood. It is therefore essential to assess their eating habits and nutritional status to effectively guide prevention and promotion strategies. This literature review aims to provide an overview of the available data on blood donors in relation to their nutritional, biochemical and hematological profiles. The research was conducted using several scientific search engines and databases (Google Scholar, WHO and EFS publications, PubMed, MEDLINE, ScienceDirect). Of the 994 articles reviewed, only eight addressed hematological aspects (hemoglobin, iron, red and white blood cells, platelets) and none explored nutritional or biochemical profiles. These results highlight the need to integrate nutritional considerations into donor promotion and monitoring policies to enhance transfusion safety.

Key words: Blood donation, micronutrients, nutrition, biochemical parameters, transfusion safety

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Transfusion safety is a non-negotiable issue worldwide, according to the World Health Organization[1]. Africa and more specifically Sub-Saharan Africa, is both a single entity and a multiplicity of internal and cross-border situations[2]. This situation is becoming a cause for concern as it poses a challenge to public health[3,4]. Blood is a vital physiological fluid and despite scientific advances, medicine has not yet succeeded in synthesizing effective artificial blood. Blood is also a complex fluid, containing living cells, each of which performs one or more vital functions[5]. In cases of blood loss, there is usually no alternative to blood transfusion. Blood donation, therefore, still has a bright future ahead of it. For this reason, in many countries, demand exceeds supply and transfusion services around the world face the ongoing challenge of providing an adequate supply of blood products while ensuring their quality and safety in the face of known and emerging threats to public health[6]. Worldwide, for example, the number of donations recorded in 2016 was approximately 118.5 million for a population of over 7 billion. Of this figure, 31.5‰ came from high-income countries, compared with 5‰ from African countries and more specifically, Sub-Saharan African countries[7], including Togo. This low proportion of donations in African countries is in fact the result of insufficient care, awareness and guidance for blood donors, combined with a lack of data on their nutritional status and general health. Blood donation causes micronutrient loss in donors, especially regular donors, particularly iron and vitamins (B9, B12)[8-10]. Specifically, a 450 mL blood donation can result in a loss of 213 to 236 mg of iron, which corresponds to at least 100 days of dietary iron intake[9]. From this perspective, a good diet, especially one of high quality, would enable blood donors to obtain these micronutrients that are essential to the hematopoietic system. Furthermore, in order to provide blood donors with the essential nutrients they need, this diet should focus on traditional or local foods. A traditional or local diet is therefore healthy and rich in a variety of essential nutrients (iron, zinc and vitamins A, B, C and D)[11]. The foods that make up this diet are generally high in animal protein and often rich in essential fatty acids and their consumption l sec widely promoted for its benefits to overall health[11]. Other factors, such as insufficient promotion of blood donation, religious issues and misunderstandings surrounding the sale of collected blood, also hinder blood donation[12,13]. To this end, according to the WHO[7], only 20% of uncontaminated blood is available for 80% of the world's population. On this subject, scientific researchhas focused much more on the clinical aspects of donors, the measurement of certain hematological parameters and advice on managing their health[14].

The objective of this review is to take stock of previous studies that have addressed the quality of nutrition among blood donors in order to consider further studies for a holistic view of the issue of blood donation.

MATERIALS AND METHODS

Study protocol and databases: The research was conducted using electronic databases such as Google Scholar, PubMed, ScienceDirect and MEDLINE. In addition to these databases, the WHO World Health Assembly resolutions and EFS publications were consulted. Various works were also considered, drawing on dissertations and theses produced in Algeria, Morocco, Belgium and France, notably those from the University of Carthage, Abdelhamid Ibn Badis University in Mostaganem, the University of Grenoble, the University of Paris and the Catholic University of Louvain.

Eligibility criteria: The articles selected were those published in English or French between 1980 and 2023. This study includes articles, master's theses and doctoral dissertations that are published online and focus on the eating habits and nutritional and biochemical profiles of blood donors. Literature reviews were not considered in this study.

Table 1: Summary of the databases consulted, the populations studied and the issues investigated

Databases	Population/problem	Intervention	Comparison group	Results
PubMed	Blood Blood donors Blood donation Anemia	Assessment of the nutritional status and biochemical profile of blood donors	A subject who has never donated blood and has just started	Deterioration in nutritional status and biochemical profile or not
Google scholar	Biochemical profile OR biochemical parameters Nutritional profile OR nutritional status AND eating habits	Assessment of the nutritional status and biochemical profile of blood donors	Subject who has never donated blood and has just started	Deterioration in nutritional status and biochemical profile or not
ScienceDirect MEDLINE	Nutrition Nutritional profile OR status Body composition Eating habits	Assessment of the nutritional status and biochemical profile of blood donors	Subject who has never donated blood and has just started	Deterioration in nutritional status and biochemical profile or not

Search strategy: The research question was formulated according to the PICO criteria (P = population, I = intervention, C = comparison group and O = outcomes)[15] (Table 1). The terms used in each component were searched using the Boolean operator "OR" and the components were linked together using the Boolean operator "AND" to perform the search (Table 1). The search strategy was adapted for each database using keywords or groups of keywords (Table 1). All search records were exported to the EndNote reference management software. The following question is the subject of this study: "Does blood donation have an impact on the nutritional and biochemical profiles of donors?"

The detailed search strategy, including the complete search equations used for each database, is presented in Supplementary Table S1.

Data selection and extraction: Original studies related to the nutritional and biochemical profiles of blood donors were those to be included according to the selection criteria. The selection of studies from electronic databases was then carried out by two authors working independently. No discrepancies were observed. Titles and abstracts were initially screened to exclude articles outside the scope of the review. Studies were considered definitively eligible for inclusion when results were available and included one of the following parameters: Dietary habits, anthropometric and biochemical parameters and nutritional status of blood donors. For all remaining articles, full-text versions were located for review.

The information collected depended on the categories of study details, population characteristics, study protocol, objective measurement tools, subjective measurement tools and results obtained.

Assessment of report quality: All full-text versions of potentially relevant research data were independently reviewed by three reviewers to determine whether studies were definitively eligible for inclusion and to assess their quality. Study quality was assessed using the Newcastle-Ottawa Scale for cohort studies[16]. The scale includes three quality criteria: selection, comparability and outcome. The maximum score is 9 points (4 for selection, 2 for comparability and 3 for outcome). Study quality was defined as poor when the score was 1 to 3, fair when the score was 4 to 6 and good when the score was 7 to 9 points.

RESULTS

Figure 1 shows the selection process that identified 994 studies, of which 490 were excluded as duplicates. After analyzing the titles of the articles, 498 had titles that were not relevant to the subject of this review. However, six articles dealt with hematological aspects and iron levels in blood donors and biochemical parameters in platelet donors (Fig. 1), but none of the articles addressed the nutritional and biochemical profiles of blood donors and, worse still, their dietary habits in relation to nutrient requirements (Fig. 1).

The study selection process was conducted in accordance with the PRISMA guidelines (Supplementary Fig. S1).

Status of studies addressing certain aspects of the review: Table 2 shows the characteristics of studies addressing certain aspects of the review. The results of hematological aspects, iron levels in blood donors and changes in biochemical parameters in platelet donors are detailed in Table 2.

The detailed characteristics of the included studies and the extracted data are presented in Supplementary Table S2.

Hematological aspects, iron, biochemical parameters (calcium, magnesium, albumin, total protein): Three studies reported data on hematological aspects in blood donors[9,17,18]. Five different studies addressed iron levels in these donors[9,20-23]. These studies identified different types of anemia and noted variations in iron deficiency among these donors based on age, sex and the number of donations made. Only one study was based on biochemical parameters in platelet donors[23] (Fig. 2 and Table 3).

Summary of selected studies: The methodological quality and risk-of-bias assessment of the included studies, evaluated using the Newcastle-Ottawa Scale, are presented in Supplementary Table S3.

DISCUSSION

According to the literature review, there are no articles that address the nutritional and biochemical profiles of blood donors. However, there is one study that examined biochemical parameters in platelet donors[23]. Furthermore, studies that have addressed the hematological aspect and iron levels in blood donors have shown beneficial results for the majority of these donors. However, these studies present unsatisfactory results for some of these donors and reveal many shortcomings in promoting the health of these donors.

Considering this literature review, there is no information available on the adequacy of nutritional intake and nutrient requirements in blood donors, specifically vitamins B9 and B12 and proteins. B vitamins play important roles in various tissues

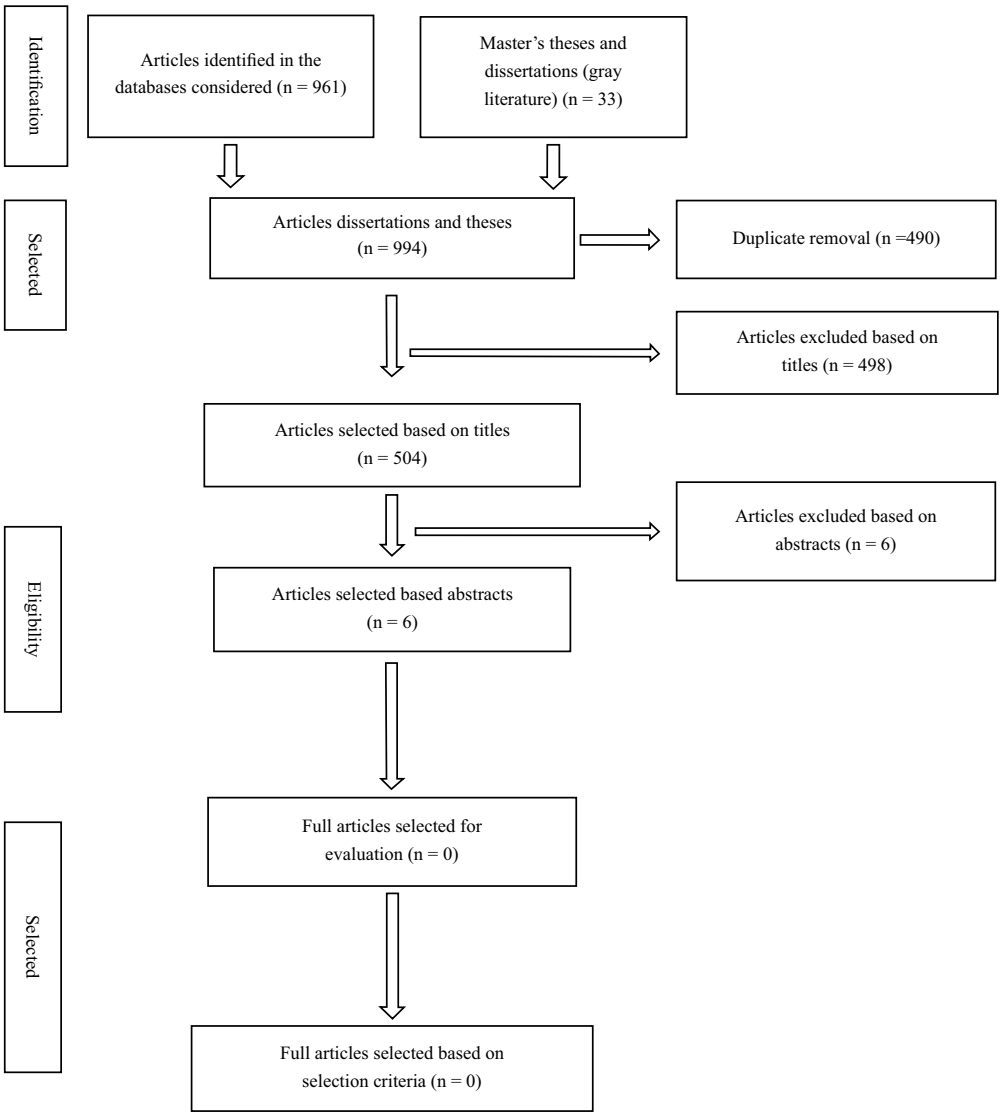

Fig. 1: Summary of the article selection process

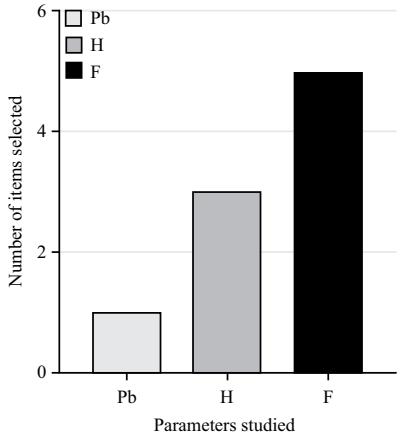

Fig. 2: Histogram of selected studies

Pb: Biochemical parameters, H: Hematology and F: Iron, Graphical representation of selected items

Table 2: Characteristics and key findings of included studies on blood donors

Authors and year of the study	Country in which the study is conducted	Types of studies	No. of participants	Results obtained
Bakrim *et al.*[17]	Morocco	Cross-sectional and descriptive study	15797 donors	1,054% women and 245 men were anemic
Fillet *et al.*[18]	France	Prospective national multicentre study	7200 donors	Analysis of white blood cells showed leukopenia in 324 blood donors and 807 cases of hyperleukocytosis
Jeremiah *et al.*[9]	Nigeria	Cross-sectional and descriptive study	348 donors	The study of the platelet lineage showed thrombocytopenia in 627 blood donors and thrombocytosis in 151 cases
Lee *et al.*[19]	Hong Kong	Prospective study	836 donors	These studies showed iron deficiency (63.2, 20.6 and 43%), anemia and iron deficiency anemia in these blood donors, proportional to the number of donations
Nzengu-Lukusa *et al.*[20]	RDC	Cross-sectional study	386 donors	Certain factors such as gender, age, number of donations and the interval between the last two donations were associated with this deficiency and iron deficiency anemia: A prevalence of iron deficiency ranging from 0% at the first donation to 35.1% among regular male blood donors, while among women, this deficiency ranged from 7.2 to 65%. The same is true in a study in America, where the prevalence was almost ten times higher among regular blood donors with more than ten donations (31%) compared to that of the first donation
Boulahriss and Benchemsi[21]	Nigeria	Cross-sectional and descriptive study	348 donors	
Bakrim *et al.*[17]	Morocco	Retrospective study	42 donors	
Cable *et al.*[22]	America	Prospective study	2425 donors	
Garg *et al.*[23]	India	Cross-sectional and descriptive study	60 donors	There was a statistically significant decrease in mean total calcium (9.27±0.66 to 8.72±0.87 mg/dL) and ionized calcium (3.8±0.51 to 2.9±0.67 mg/dL) from baseline to 30 min after the start of the procedure, respectively. A significant decrease in serum magnesium, total protein and serum albumin was observed. Parathyroid hormone showed a significant increase from baseline levels until the end of the procedure (19.94±12.1 to 92.08±36.78 pg/mL)

Table 3: Summary of parameters assessed across included studies

	Hematological aspect			Iron	Biochemical parameter			Socio-demographic characteristics			
References	1	2	3	4	5	6	7	8	9	10	11
Bakrim *et al.*[17] and Kossi *et al.*[34]	+	+	+	-	-	-	-	-	+	+	+
Jeremiah *et al.*[9]	+	+	+	+	-	-	-	-	+	-	+
Fillet *et al.*[18]	+	+	+	-	-	-	-	-	+	+	+
Boulahriss and Benchemsi[21]	-	-	-	+	-	-	-	-	+	-	+
Cable *et al.*[22]	-	-	-	+	-	-	-	-	+	-	+
Lee *et al.*[19]	-	-	-	+	-	-	-	-	+	-	+
Nzengu-Lukusa *et al.*[20]	-	-	-	+	-	-	-	-	+	+	+
Garg *et al.*[23]	-	-	-	-	+	+	+	+	+	+	+

+: Parameters considered in the study, -: Parameters not considered in the study, 1: Red blood cells, 2: White blood cells, 3: Platelets, 4: Iron, 5: Ca, 6: Mg, 7: Albumin, 8: Total protein, 9: Age, 10: Sex and 11: Number of donations

of the body, including blood. For this reason, deficiency in these vitamins affects rapidly renewing tissues, including blood[24] and this deficiency is one of the priorities identified by the WHO in the public health management of nutritional deficiencies. These are important parameters in blood donors because of their crucial role in the hematopoietic system. The body needs folic acid for DNA synthesis, repair and methylation[25,26]. To this end, a decrease in dietary intake or absorption of folate leads to a decrease in serum and tissue concentrations, half of which is present in the liver in sufficient quantities for four months. As a result, the most common consequence of deficiency is hematopoietic, a direct reflection of the decrease in DNA synthesis, the effect of which is predominant in rapidly renewing tissues[27]. Vitamin B12 plays a fundamental role in erythropoiesis; therefore, along with an increase in the quantity and quality of dietary protein intake, it can help prevent the onset of sometimes severe anemia[27]. A deficiency in vitamin B12 can have negative effects on the body. The most common disease caused by vitamin B12 deficiency is pernicious anemia, which accounts for about 70% of vitamin B12 deficiencies[28]. This explains the decrease in erythrocyte DNA synthesis, the effect of which also predominates in rapidly renewing tissues[29].

A sufficient amount of these vitamins in an individual, particularly a blood donor, would therefore enable the hematopoietic system to function properly.

Furthermore, no data has taken into account the dosage of homocysteine, a sulfur-containing amino acid synthesized in all cells of the human body[30]. Its metabolic regulation is controlled by the Methyl Tetrahydrofolate (MTHFR) gene and B vitamins (B6, B9 and B12). Any disruption in either of these two mechanisms would therefore lead to an increase in the blood level of this amino acid[31]. This can cause a polymorphism with adverse effects on the enzymatic activity of the Methyl Tetrahydrofolate (MTHFR) gene.

It would be essential to check the level of this amino acid in blood donors to take all necessary measures to prevent such a phenomenon (polymorphism).

In addition to these vitamins and homocysteine, albumin, which is the most important protein in human serum or plasma, accounts for approximately 50% of the total content of the latter[32]. No information is provided on this protein to reflect the nutritional status of blood donors, even though blood donation, particularly plasma donation, involves this protein[33].

These micronutrients are supplied to the body exclusively through diet and the issue of nutrition is therefore essential for blood donors. In order to resolve nutritional issues among these donors, it would be useful to know whether they have a diverse and varied diet that provides the body with the essential nutrients it needs to function properly[34]. In addition, it is also necessary to know the dietary habits of blood donors and according to this literature review, no study on donors has addressed this aspect. However, these parameters are essential for assessing the content and qualitative variation of the food consumed by blood donors, as well as the coverage of macronutrient and micronutrient requirements. All of this will contribute to better promotion of blood donors' health in order to enable the hematopoietic system to function properly[34-36].

CONCLUSION

This review underscores that adequate and diversified nutrition is fundamental to maintaining donor health and ensuring safe blood donation. Sufficient intake of key micronutrients particularly iron, folate, vitamin B12 and vitamin C is essential for effective hematopoiesis and post-donation blood cell regeneration, while deficiencies may compromise hemoglobin synthesis and transfusion safety. Integrating targeted nutritional education into voluntary blood donation programs is therefore critical, especially in Sub-Saharan Africa where nutritional inadequacies remain prevalent. Such strategies can protect regular donors, enhance blood quality and sustainably strengthen transfusion safety systems.

SIGNIFICANCE STATEMENT

This review provides evidence that donor nutrition directly influences hematopoiesis, post-donation recovery and transfusion safety. By synthesizing data on iron, folate, vitamin B12 and vitamin C, it clarifies how micronutrient adequacy preserves hemoglobin synthesis and blood quality. The findings support integrating targeted nutritional education into voluntary blood donation programs, particularly in Sub-Saharan Africa, to protect donor health, improve collected blood quality and strengthen sustainable transfusion systems at policy and practice.

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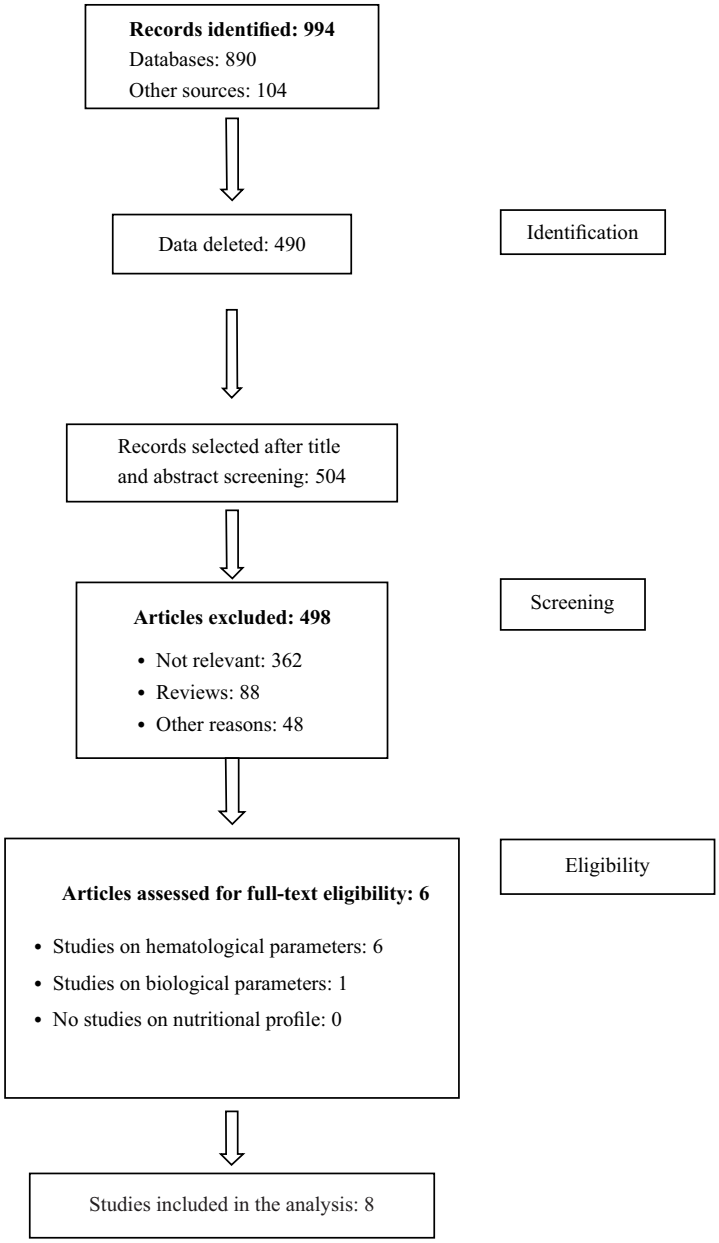
SUPPLEMENTARY DATA



Supplementary Fig. 1: PRISMA flow diagram of the study selection process

Supplementary Table 1: Detailed search strategy used for the systematic review

Database	Search strategy (keywords and Boolean operators)	Period covered	Language
PubMed	("blood donation" OR "blood donors") AND ("nutritional status" OR "nutritional profile" OR "dietary habits" OR nutrition) AND ("biochemical parameters" OR "biochemical profile" OR micronutrients OR iron OR anemia)	1980-2023	English
Google Scholar	("blood donors" OR "blood donation") AND ("nutritional status" OR "nutritional profile" OR "eating habits") AND ("biochemical profile" OR "biochemical parameters" OR micronutrients)	1980-2023	English/French
ScienceDirect	("blood donors" AND nutrition) OR ("nutritional status" AND blood donation) AND ("biochemical parameters" OR iron OR vitamins)	1980-2023	English
MEDLINE	("blood donation" AND nutrition) AND ("biochemical profile" OR hematological parameters OR iron deficiency)	1980-2023	English
Other sources	WHO World Health Assembly resolutions, EFS publications, academic theses and dissertations	1980-2023	English/French

Supplementary Table 2: Extended data extraction table of included studies

Authors	Country	Study design	Sample size	Population	Parameters assessed	Main findings
Bakrim *et al.*[17]	Morocco	Cross-sectional	15,797	Blood donors	Hematological parameters (RBC, WBC, platelets), iron	Presence of anemia, leukopenia, thrombocytopenia; iron deficiency observed
Fillet *et al.*[18]	France	Prospective multicenter study	7,200	Blood donors	Hemoglobin, iron status	Iron deficiency related to donation frequency
Jeremiah *et al.*[9]	Nigeria	Cross-sectional	348	Blood donors	Hematological parameters, iron	Iron deficiency and anemia associated with repeated donations
Lee *et al.*[19]	Hong Kong	Prospective study	836	Blood donors	Iron status	Progressive iron depletion with increased number of donations
Nzengu-Lukusa *et al.*[20]	DR Congo	Cross-sectional	386	Blood donors	Iron status	High prevalence of iron deficiency, influenced by sex and donation frequency
Boulahriss and Benchemsi[21]	Morocco	Retrospective	42	Blood donors	Iron	Iron deficiency observed in regular donors
Cable *et al.*[22]	USA	Prospective study	2,425	Blood donors	Iron, hemoglobin	Higher prevalence of iron deficiency in frequent donors
Garg *et al.*[23]	India	Cross-sectional	60	Platelet donors	Calcium, magnesium, albumin, total protein	Significant decrease in biochemical parameters during AP

Supplementary Table 3: Quality assessment and risk-of-bias evaluation using the newcastle-Ottawa scale

Study	Selection (max 4)	Comparability (max 2)	Outcome (max 3)	Total score (max 9)	Study quality
Bakrim *et al.*[17]	3	2	2	7	Good
Fillet *et al.*[18]	4	2	3	9	Good
Jeremiah *et al.*[9]	3	1	2	6	Fair
Lee *et al.*[19]	3	2	2	7	Good
Nzengu-Lukusa *et al.*[20]	3	1	2	6	Fair
Boulahriss and Benchemsi[21]	2	1	2	5	Fair
Cable *et al.*[22]	4	2	3	9	Good
Garg *et al.*[23]	3	1	2	6	Fair

Interpretation: Scores of 7-9 indicate good quality, 4–6 fair quality and $\leq$3 poor quality