

Full Length Research Paper

Serum protein fractions evaluation in blood donors in Ouagadougou, Burkina Faso

Alice KIBA-KOUMARÉ^{1,2,3*}, Guetabamba Arnaud KOURAOGO⁴, Fabienne SOUDRÉ^{1,5}, Raoul KARFO¹, Elie KABRÉ¹ and Jean SAKANDÉ^{1,4}

¹Health Sciences Training and Research Unit, Joseph Ki-Zerbo University, Ouagadougou, Burkina Faso.

²National Blood Transfusion Center, Ouagadougou, Burkina Faso.

³Tengandogo Teaching Hospital, Ouagadougou, Burkina Faso.

⁴Yalgado Ouedraogo Teaching Hospital, Ouagadougou, Burkina Faso.

⁵Charles de Gaulle Pediatric Teaching Hospital, Ouagadougou, Burkina Faso.

Received 8 February, 2024; Accepted 12 April, 2024

To contribute to the assessment of blood donor health at the Regional Blood Transfusion Center of Ouagadougou (CRTSO), we evaluated serum protein fractions in voluntary blood donors. The study included individuals deemed fit to donate blood after a pre-donation medical interview at the CRTSO. Data, including blood grouping and serology results (HIV, HBV, HCV and syphilis) were collected during the pre-donation medical interview and after the biological qualification of blood donations at the CRTSO. Serum protein electrophoresis was conducted using the Helena SAS-3/4 automaton through migration on agarose gel. Data analysis was performed using Epi-info version 7.2.1.0. A total of 110 voluntary blood donors participated, with a predominance of men (67.27%). The mean age was 28.11 ± 8.24 years, ranging from 18 to 56 years. Approximately 37.27% were new donors and 22.73% were carriers of hemoglobinopathy. Among the 8 donors with positive serology, 7 were new donors, accounting for 87.5%. Analysis of serum protein fractions revealed that 17.28% of donors had high total protein, 38.18% had high albumin, 50.90% had low α -2 globulins and 5.45% had high γ -globulins. About 25% of blood donors, mainly new donors, exhibited disturbances in serum protein fractions. New donors showed higher total protein and γ -globulins values compared to old donors. These findings suggest that blood donors, especially new donors, may not always be in perfect health. Serum protein fractions, in conjunction with blood donor selection tests, can unveil certain infectious or inflammatory conditions that may have been overlooked during clinical selection. This reinforces transfusion safety and enhances medical care for blood donors.

Key words: Serum protein fractions, blood donation and transfusion, National Blood Transfusion Center (NBTC).

INTRODUCTION

Blood transfusion occupies an important place in the therapeutic arsenal of many sub-Saharan African countries

where conditions causing anemia are endemic. Indeed, in these countries, malaria, hemoglobinopathies, obstetric

*Corresponding author. E-mail: alice_kiba@yahoo.fr.

Author(s) agree that this article remain permanently open access under the terms of the [Creative Commons Attribution License 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

hemorrhages, and other nutritional deficiencies are all causes that risk exposing an individual to transfusion (Zamané et al., 2014). In Burkina Faso, the collection and distribution of labile blood products (LBP) are the responsibility of the National Blood Transfusion Center (CNTS), which organizes blood donations. In order to ensure transfusion safety, blood donors are selected based on well-defined criteria. The purpose of donor selection is to determine whether they are healthy and to ensure that donating blood will not harm their health. Thus, the selection of donors is based on a medical consultation (measurement of weight, blood pressure, and clinical examination) and a pre-donation medical interview, which aims to reduce transfusion incidents and accidents.

A targeted biological assessment (ABO Rh blood grouping, search for HBs antigens, anti-HCV, anti-HIV, antitreponemal antibodies) is also carried out on each donation to ensure transfusion safety. While these criteria minimize the risks of spreading diseases transmitted by blood, they cannot ensure the good health of blood donors, especially since a significant portion of the evaluation of their health status relies on their own statements during interrogation (Nébie et al., 2017). Additionally, it's known that some endemic conditions in our country exhibit specific epidemiological patterns, and there may be disruptions in serum protein fractions, indicating infection and inflammatory syndrome (Ankouane et al., 2016).

Serum proteins play various roles in the body, and their quantitative variations, whether isolated or not, are observed at early stages of the acute phase during various conditions such as infectious, parasitic, bacterial, and viral illnesses, as well as during immune reactions and malnutrition. Studies conducted on several African populations have demonstrated protein imbalances in the serum of black Africans, characterized by hypoalbuminemia linked to hypergammaglobulinemia. These studies have shown that the concentration of gamma globulins often reaches a value of 25 to 45% of the total protein level (Sombo-Mambo et al., 1998; Yayo et al., 2009). Thus, we conducted this study to evaluate the serum protein fractions of blood donors from the Ouagadougou regional blood transfusion center (RBTC-O) with the aim of contributing to the assessment of their health status.

MATERIALS AND METHODS

This was a cross-sectional study with a descriptive aim which took place from February to June 2022 in Ouagadougou, capital of Burkina Faso. The study population consisted of 110 blood donors declared suitable for blood donation following the pre-donation medical interview at the RBTC-O. Subjects were recruited by simple random sampling after the pre-donation medical interview. We included in our study any blood donor declared suitable of donating blood after the pre-donation interview and having given their informed consent to participate in the study. These are therefore people with the following characteristics:

- (1) Be between the ages of 18 and 60, regardless of gender;
- (2) Not be pregnant, breastfeeding, or menstruating for women;
- (3) Not having donated blood for at least three months for women and two months for men;
- (4) Be in apparent good health according to the conclusions of the medical examination carried out on the day of donation during the pre-donation medical interview (anthropometric constants, questioning, and clinical examination).

The study excluded individuals who were deemed ineligible for blood donation during the pre-donation medical interview, as well as those who did not provide informed consent for participation. Sociodemographic variables, including age, sex, donor type, and number of donations, were examined. Biological variables investigated included blood group, serological parameters for HIV, HBV, HCV, and syphilis, hemoglobin electrophoresis, and serum protein electrophoresis. The CRTSO's biological qualification results for donations provided the basis for collecting biological variables such as blood group and serological testing for bloodborne infections. Serum protein electrophoresis involved centrifuging whole blood collected in a dry tube at 3500 rpm for 5 min, followed by immediate aliquoting into cryotubes and storage at 0°C for a maximum of 7 days until assay. Serology was conducted using the COBAS e601 machine from Roche Diagnostic®, while protein electrophoresis utilized the Helena SAS-3/4 system. Blood grouping was performed on opaline plates. The measurement methods, dosing principles, and reference values of the various biological variables are summarized in Table I. Data were collected using individual survey forms after obtaining informed consent from blood donors and then analyzed using Epi Info® software version 7.2.1.0. Quantitative variables were presented as mean \pm standard deviation, and qualitative variables were expressed as percentages. The comparison of means was performed using the Student t-test, and the comparison of percentages was conducted using the Pearson chi-square test. A probability of less than 0.05 was considered significant for all variables.

Ethical approval

The study received approval from the institutional ethics committee of the National Blood Transfusion, with reference number N° 2021/12-10/MSHP/SG/CNTS/DG. Authorization for data collection was granted by the management of the National Blood Transfusion. All participants provided their free and informed consent to participate in the study. Data confidentiality was strictly upheld throughout the study.

RESULTS

General profile of blood donors and blood donation data

The average age of blood donors was 28.11 ± 8.24 years, ranging from 18 to 56 years. The age group of 18 to 25 years was the most represented, accounting for 51.82% of the total with 57 blood donors. Predominantly, blood donors were male (67.27%), resulting in a male/female sex ratio of 2.05. Blood group O was the most prevalent among donors (52.73%), while group AB was the least common (8.18%). Regarding rhesus factor, 90.91% of donors were rhesus positive. The majority of donors were former

Table 1. Methods, dosing principle and reference values of the biological variables studied.

Settings	Methods	Dosing principle	Reference value
Serologies HIV, HBV, HCV, Syphilis	Immunochemistry	Chemiluminescence	Negative
Blood group	Beth-vincent / Simonin-Michon	Ag/ Ac agglutination	A, B, AB, O
Total protein	Colorimetric	Biuret	60-80 g/L
Hemoglobin	Electrophoresis	Migration on agarose gel in an electric field	AA
Albumin			35-50 g/L; 60-70%
α -1 globulins			1-3 g/L; 1-4%
α -2 globulins	Electrophoresis	Migration on agarose gel in an electric field	6-11 g/L; 6-10%
β -globulins			7-13 g/L; 8-12%
γ -globulins			5-15 g/L; 12-19%

Table 2. General characteristics of the population studied.

Characteristics n=110		Blood donors
Mean age (years) (m \pm SD)		28.11 \pm 8.24
Sex n (%)	Man	74(67.27)
	Women	36(32.73)
	M/F ratio	2.05
Donor type n (%)	New	41(37.27)
	Old	69(62.73)
Number of donations (m \pm SD)	Total	5.95 \pm 9.47
	Man	6.82 \pm 10.86
	Women	4.16 \pm 5.35
Blood group n (%)	A	17(15.46)
	B	26(23.64)
	AB	9(8.18)
	O	58(52.73)
Rhesus n (%)	Positive	100(90.91)
	Negative	10(19.09)

donors (62.73%), with an average of 5.95 \pm 9.47 donations per donor, ranging from 1 to 57. Men had a higher average number of donations (6.82 \pm 10.86) compared to women (4.16 \pm 5.35) (Table 2). Hemoglobin typing revealed a predominantly normal hemoglobin profile (HbAA) in 77.27% of blood donors, while 22.73% exhibited hemoglobinopathies. The observed frequencies of hemoglobinopathies were as follows: AS (3.64%), AC (16.36%), and CC (2.73%).

Serum proteins profile of blood donors

The majority of blood donors exhibited normal levels for

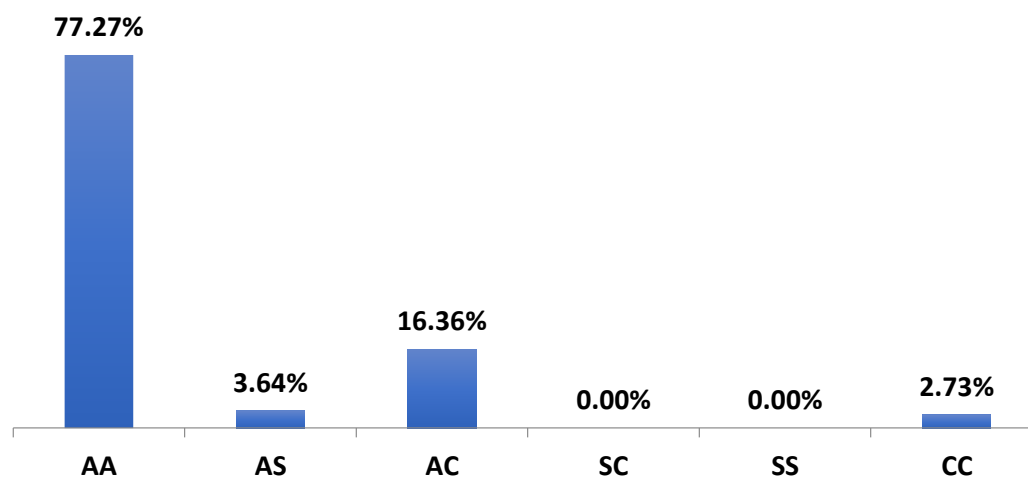
total protein, albumin, α -1 globulins, β -globulins, and γ -globulins. Mean values of serum protein fractions varied according to the type of donor, indicating significantly higher mean values of total proteins and γ -globulins in new blood donors compared to old donors ($p < 0.05$) (Table 3). The overall frequency of blood-borne infections among donors (Table 4) was 7.27%, with 3.64% for HBV, 0.91% for HCV, and 2.73% for syphilis. Among donors with blood-borne infections, all cases of HBV and HCV infections were observed in new donors, while former donors accounted for 0.91% of positive syphilis cases. Mean serum protein fractions values were higher in donors with blood-borne infections compared to those with negative serology. Figure 1 shows the distribution of blood donors

Table 3. Protein profile of the studied population.

Protein fractions (m±SD)	Total population n=110	New Donors n=41	Former Donors n=69	p -value
Total protein	74.94±7.14	76.66 ± 6.54	73.91 ± 7.28	0.046
Albumin	68.63±4.00	68.23±3.74	68.86±4.13	0.414
α-1 globulins	2.34±0.55	2.45±0.60	2.28±0.50	0.130
α-2 globulins	6.28±2.09	6.33±2.33	6.26±1.93	0.870
β-globulins	8.85±2.03	8.88±2.09	8.83±1.99	0.900
γ-globulins	13.90±2.51	14.11±2.61	13.77±2.44	0.049

Table 4. Prevalence of blood-borne infections and mean serum protein fractions values according to serology.

Characteristics n=110	Positive serology n=8	Negative serology n=102
Blood-borne infections	HIV n(%)	0(00.00)
	HBV	4(3.64)
	HCV	1(0.91)
	Syphilis	3(2.73)
Protein fractions (m±SD)	Total protein	77.75±3.42
	Albumin	65.68±1.99
	α-1 globulins	2.72±0.58
	α-2 globulins	7.78±3.45
	β-globulins	8.14±2.60
	γ-globulins	15.68±2.52

**Figure 1.** Distribution of blood donors according to hemoglobin type.

according to hemoglobin type.

Figure 2 illustrates the frequency of serum protein fractions disturbances among blood donors, indicating that 17.28% presented total hypoproteinemia, 38.18% hyperalbuminemia, 50.90% hypo-α2-globulinemia, 30.91% hypo-β-globulinemia, and 21.82% hypogammaglobulinemia.

DISCUSSION

General characteristics of the population

The blood donor cohort comprised individuals aged 18 to 56 years, with the majority falling within the 18-25 age group (51.82%). Age groups not represented in our

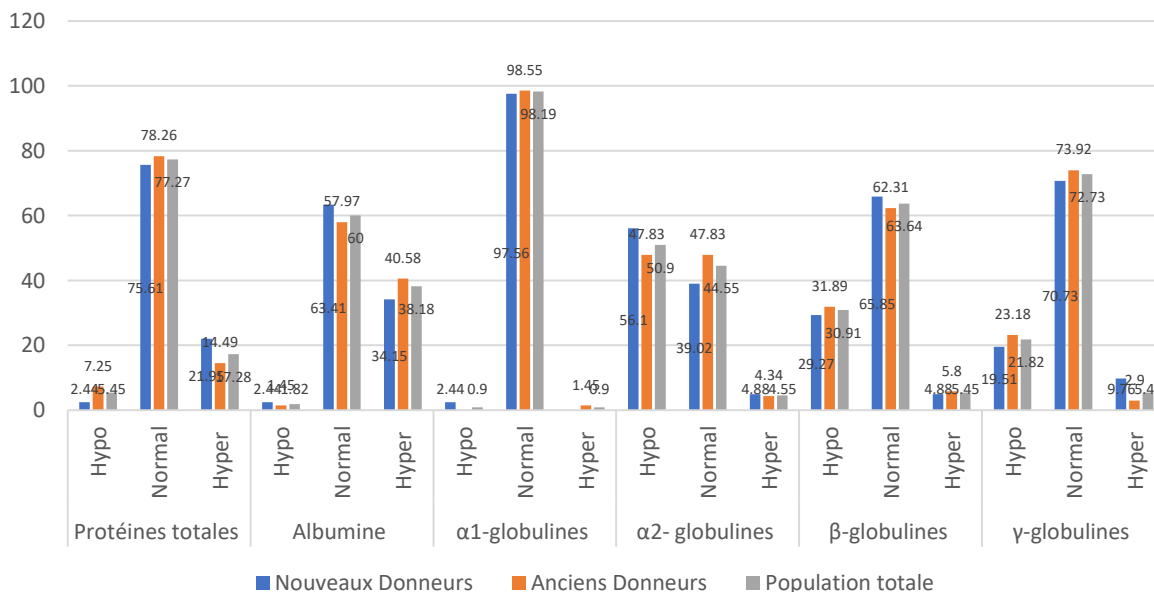


Figure 2. Frequency of disturbances of the serum protein fractions according to the type of donor.

sample, such as 0 to 17 years and those over 60, are typically excluded from blood donation. This aligns with the demographic pattern observed in the National Blood Transfusion Center (NBTC) of Burkina Faso, as noted by Sawadogo et al. (2019), and is consistent with trends observed in other African countries (Tessema et al., 2010; Noubiap et al., 2013; Kabinda et al., 2014; Ankouane et al., 2016; Mohammed and Bekele, 2016).

The donor population in our study was predominantly male (67.27%), with females comprising only 32.73%. This male predominance among blood donors in sub-Saharan Africa, including Burkina Faso, Democratic Republic of Congo, and Ivory Coast, has been documented in previous studies (Yayo et al., 2009; Kabinda et al., 2014; Nagalo et al., 2012). This gender disparity may be attributed to various factors, including physiological differences (e.g., menstruation, pregnancy, breastfeeding) that limit female eligibility for blood donation. Additionally, the donation frequency is higher for men (four times a year) compared to women (three times a year) in Burkina Faso.

All donors in our study (100%) were voluntary non-profit donors, with 37.27% being new donors and 62.73% previous blood donors. This distribution is consistent with findings from other studies (Namululi et al., 2013; Nzaji and Ilunga, 2013) where volunteer donors outnumbered family donors. However, some studies in Africa have reported a predominance of replacement/family donors compared to volunteer donors (Mohammed and Bekele, 2016; Koné et al., 2012). Our results reflect the exclusive reliance on volunteer donors for blood supply at the NBTC in Burkina Faso.

Blood group O was the most prevalent among donors in our sample (52.73%), followed by group B (23.64%), with

group AB comprising only 8.13% of donors. This distribution is consistent with observations from previous studies conducted in Burkina Faso (Sawadogo et al., 2019; Nagalo et al., 2012).

Serum protein fractions profile of the study population

Analysis of the serum protein fractions revealed that the majority of blood donors (77.27%) exhibited a normal total protein level, averaging 74.94 ± 7.14 g/l, with only 5.45% showing low levels. However, 17.28% of donors had elevated total protein levels. This elevation could be attributed to increased albumin levels, known for their ability to retain water. Previous studies have highlighted significant modifications in albumin and γ -globulins, the extreme fractions of the electrophoretic spectrum (Ayad et al., 2021; Seck et al., 2016).

Regarding blood albumin levels, the majority of donors (60.00%) exhibited normal levels, averaging 51.39 ± 5.36 % of total proteins, with 38.18% showing elevated albumin levels. Only 1.82% had low albumin levels. Hypoalbuminemia has been reported in some studies (Sombo-Mambo et al., 1988; Py et al., 2013). These findings suggest a favorable nutritional status among blood donors and affirm that blood products, particularly fresh frozen plasma (FFP), provided by the CNTS, are rich in albumin.

Most donors (98.00%) displayed normal α -1 globulin levels, averaging 1.75 ± 0.42 % of total proteins, with only 0.90% exhibiting elevated α -1 globulin levels. This indicates that the majority of donors in our series did not present pathologies associated with variations in these

proteins.

The α -2 globulin level was normal in 44.55% of donors, averaging $4.72 \pm 1.68\%$ of total proteins. However, a high level was observed in 4.55% of blood donors. Previous studies by Yayo et al. (2009) and Seck et al. (2016) found high levels of α -2 globulins at around 50%. These results indicate that not all selected blood donors are in optimal health. Donors with inflammations of various origins should have been excluded during the medical examination, as febrile episodes and other clinical signs suggestive of infections or inflammation would have been emphasized in the weeks preceding donation.

This situation raises concerns about the accuracy of responses provided by blood donors during the medical interview. Blood donation must ensure the safety of both the blood recipient and the donor (Danic, 2005; Rabeya et al., 2008). In certain cases of underlying infection or inflammation, donating a certain volume of blood (300-500 ml) could potentially compromise the health of the donor by exacerbating existing pathologies (Danic, 2005; Nèbie et al., 2017).

The majority of our donors (63.64%) exhibited normal β -globulin levels, with an average level of $6.62 \pm 1.64\%$ of total proteins. However, 30.91% had low levels and 5.45% had high levels. These findings align with those reported by Yayo et al. (2009) and Seck et al. (2016).

Approximately 72.73% of donors displayed normal γ -globulin levels, averaging $10.46 \pm 2.36\%$ of total proteins, while 5.45% had high levels. These results contrast with those of numerous studies reporting hypergammaglobulinemia in black subjects residing in tropical regions. The higher immunoglobulin concentrations in these subjects reflect a frequently stimulated immune system due to constant environmental infectious challenges, constituting a physiological response (antibody synthesis) to attacks by various parasitic, bacterial, and viral agents (Yayo et al., 2009; Seck et al., 2016; Py et al., 2013). Among the subjects deemed suitable for blood donation in our study, approximately 5.45% exhibited an infection (elevated γ -globulin levels). While immunological selection tests at the NBTC rule out viral infections such as HIV/AIDS and hepatitis B and C, parasitic, bacterial, and other viral infections remain potential risks that must be considered (Yayo et al., 2009).

Analysis of serum protein fractions according to donor type (Table 3) revealed that new blood donors had higher mean values of total proteins and γ -globulins compared to old blood donors. The increase in total proteins in blood donors with positive serology (HBV, HCV, syphilis) likely reflects the rise in γ -globulins induced by the infection.

Serum protein fractions and blood-borne infections

Out of the 110 blood donors, 8 individuals, representing 7.27% of the sample, tested positive for blood-borne

infections. None of the donors were positive for HIV, indicating the effectiveness of the medical questionnaire in excluding individuals with this infection. However, the frequencies of other markers such as HBV, HCV, and syphilis were 3.64%, 0.91%, and 2.27%, respectively (Table 4). Additionally, the prevalence of HBV, HCV, and syphilis carriage was higher among new donors compared to old donors. Specifically, among the 8 donors with positive serology, only one was a former donor. These low prevalences of blood-borne infections in our sample were anticipated, as voluntary donation has been associated with a lower prevalence of transfusion-transmissible agents, as noted by several authors (Tagny et al., 2012; Lefrère et al., 2011; Allain et al., 2010).

Analysis of the mean values of serum protein fractions according to serology (Table 4) revealed that the mean values of the different protein fractions fell within normal limits. However, donors with positive serology (HBV, HCV, syphilis) exhibited higher mean values of protein fractions compared to those with negative serology.

Conclusion

The results from our study indicate that most of our blood donors exhibited protein fractions within normal ranges. However, 25 out of 110 blood donors, corresponding to 22.73% of the sample, showed disturbances in their serum protein fractions. These findings suggest that some blood donors, especially new donors, may not be in optimal health.

Therefore, the assessment of serum protein fractions alongside blood donor selection tests could help identify certain infectious or inflammatory conditions that may not have been detected during clinical evaluation. This information can contribute to enhancing transfusion safety and improving the medical care provided to blood donors.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors express their gratitude to the director of the National Blood Transfusion Center of Burkina Faso and all members of the staff for their cooperation and support in facilitating this study.

REFERENCES

- Allain JP, Sarkodie F, Asenso-Mensah K et Owusu-Ofori S (2010). Relative safety of first-time volunteer and replacement donors in West Africa. *Transfusion* 50(2):340-343.
- Ankouane F, Atangana MM, Guekam PR (2016). Seroprevalence of

- hepatitis B and C viruses, HIV-1/2 and syphilis among blood donors in the Yaoundé Central Hospital in the centre region of Cameroon. *Transfusion clinique et biologique: Journal de la Societe Francaise de Transfusion Sanguine* 23(2):72-77.
- Ayad S, Addad B, Hassoune H, Hadadine F, Benoua D, Deba T, Ghazali A (2021). Profils électrophorétiques des protéines des donneurs de sang du CHU d'Oran. *Transfusion Clinique et Biologique* 28(4):S99.
- Danic B (2005). Stating technical requirements and deferral criteria for whole blood donation. *Transfusion Clinique et Biologique* 12(3):287-289.
- Kabinda JM, Miyanga SA, Misingi P, Ramazani SY (2014). Les hépatites B et C chez les donneurs bénévoles de sang et non rémunérés de l'Est de la République démocratique du Congo. *Transfusion Clinique et Biologique* 21(3):111-115.
- Koné MC, Sidibé E T, Mallé KK, Beye SA, Lurton G, Dao S, Diarra MT, Dao S (2012). Séroprévalence des virus de l'immunodéficience humaine et des hépatites B et C chez les donneurs de sang à Ségou (Mali). *Medecine et Sante Tropicales* 22(1):97-98.
- Lefrère JJ, Dahourou H, Dokekias AE, Kouao MD, Diarra A, Diop S, Tapko JB, Murphy EL, Laperche S, Pillonel J (2011). Estimate of the residual risk of transfusion-transmitted human immunodeficiency virus infection in sub-Saharan Africa: a multinational collaborative study. *Transfusion* 51(3):486-492.
- Mohammed Y, Bekele A (2016). Seroprevalence of transfusion transmitted infection among blood donors at Jijiga blood bank, Eastern Ethiopia: retrospective 4 years study. *BMC Research Notes* 9:1-6.
- Nagalo BM, Bisseye C, Sanou M, Kienou K, Nebié YK, Kiba A, Dahourou H, Ouattara S, Nikiema JB, Moret R, Zongo JD, Simpore J (2012). Seroprevalence and incidence of transfusion-transmitted infectious diseases among blood donors from regional blood transfusion centres in Burkina Faso, West Africa. *Tropical Medicine International Health* 17(2):247-253.
- Namululi BA, Guerrieri C, Dramaix MW (2013). Prevalence and incidence of HIV and hepatitis B among blood donors and estimated residual risk of transmission of HIV and HBV virus by blood transfusion. A study at the Provincial General Referee Hospital Bukavu, Democratic Republic of the Congo. *Revue D'épidémiologie et de Sante Publique* 61(2):139-144.
- Nébie KY, Olinger CM, Kafando E, Dahourou H, Diallo S, Kientega Y, Domo Y, Kienou K, Ouattara S, Sawadogo I, Ky L, Muller CP (2017). Faible niveau de connaissances des donneurs de sang au Burkina Faso ; une entrave potentielle à la sécurité transfusionnelle. *Transfusion Clinique et Biologique* 14(5):446-452.
- Noubiap JJ, Joko WY, Nansseu JR, Tene UG, Siaka C (2013). Seroprevalence of human immunodeficiency virus, hepatitis B and C viruses, and syphilis infections among first-time blood donors in Edéa, Cameroon. *International Journal of Infectious Diseases* 17(10):e832-e837.
- Nzaji MK, Ilunga BK (2013). A study of the prevalence of infectious markers in blood donors in rural areas. The case of Kamina hospital. *Sante publique (Vandoeuvre-les-Nancy, France)* 25(2):213-217.
- Py JY, Rondot S, Salih F, Gaschard P, Colin B, Dehaut F (2013). Quel bilan peut-on tirer du dosage et de l'électrophorèse des protéines des donneurs de sang? *Transfusion Clinique et Biologique* 3(20):266.
- Rabeya Y, Rapiiah M, Rosline H, Ahmed SA, Zaidah WA, Roshan TM (2008). Blood pre-donation deferrals - a teaching hospital experience. *The Southeast Asian Journal of Tropical Medicine and Public Health* 39(3):571-574.
- Sawadogo S, Nebie K, Millogo T, Kafando E, Sawadogo AG, Dahourou H, Traore F, Ouattara S, Ouédraogo O, Kienou K, Dieudonné YY, Deneys V (2019). Distribution of ABO and RHD blood group antigens in blood donors in Burkina Faso. *International Journal of Immunogenetics* 46(1):1-6.
- Seck M, Dieye B, Guèye YB, Faye BF, Senghor AB, Toure SA, Dieng N, Sall A, Toure AO, Dièye TN, Diop S (2016). Évaluation de l'efficacité de la sélection médicale des donneurs de sang dans la prévention des agents infectieux. *Transfusion Clinique et Biologique* 23(2):98-102.
- Sombo Mambo F, Seka Seka J, Cabannes R (1988). Etude des protéines totales et du protidogramme dans deux populations de Côte d'Ivoire. *Publications Médicales Africaines* 21(91):35-39.
- Tagny CT, Kouao MD, Touré H, Gargouri J, Fazul AS, Ouattara S, Anani L, Othmani H, Feteke L, Dahourou H, Mbensa GO (2012). Transfusion safety in francophone African countries: an analysis of strategies for the medical selection of blood donors. *Transfusion* 52(1):134-143.
- Tessema B, Yismaw G, Kassu A, Amsalu J, Mulu A, Emmrich F, Sack U (2010). Seroprevalence of HIV, HBV, HCV and syphilis infections among blood donors at Gondar University Teaching Hospital, Northwest Ethiopia: declining trends over a period of five years. *BMC Infectious Diseases* 10:1-7.
- Yayo SE, Hauhouot-Attoungbre M-L, Yapi Houphouet F, Ake-Edjeme A, Ahibo H, Diafouka F, Monnet D (2009). Apport du protidogramme sérique dans la sélection de donneurs de sang à Abidjan. *Immuno-analyse and Biologie Spécialisée* 24(1):32-36.
- Zamané H, Dembelé A, Sawadogo KCC, Kain P, Kiemtoré S, Diallo S, Ouédraogo I, Ouattara A, Sawadogo YA, Ouattara LP, Traore/Millogo F et Bonané B (2014). Evaluation of transfusion practice in obstetric and gynecological emergency at the Teaching University Hospital Yalgado Ouédraogo, Ouagadougou in Burkina Faso. *Science et Technique Sciences de la Santé* 37(1 & 2):101-109.