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Original Article

Transfusion-transmissible infections among blood donors in Bejaia, Algeria: ten years retrospective and comparative study

Ferhat Djoudi[1], Nadir Amir[1], Mohammed Tahar Chouikh[2]

[1] Laboratoire d'Ecologie Microbienne, Faculté des Sciences de la Nature et de la Vie, Université de Bejaia, Algérie
[2] Laboratoire Central du CHU de Bejaia, Faculté de médecine, Université de Bejaia, Algérie

Abstract

Introduction: Blood transfusion saves millions of lives year around the world; it is the most important life-saving option for blood recipients. However, this act is not without risks as contaminated blood may be the source of transfusion-transmissible infections (TTI). This is a retrospective and comparative study on the prevalence of acquired human immunodeficiency syndrome, viral hepatitis B, C and syphilis in blood donors from Bejaia province (Algeria).

Methodology: This study is designed to estimate the risk of TTIs among blood donors and the demographic associated factors. It was carried out in the serology laboratories of Bejaia blood transfusion center and Khalil Amrane university hospital. Data were collected from the archived results of screening tests for HBV, HCV, HIV and syphilis, mandatory for all blood donations, from January 2010 to December 2019. The association was considered statistically significant at $p < 0.05$.

Results: Among 140,168 donors from Bejaia province, 78,123 represent the urban population and 62,045 the rural population. Over 10 years, results of serological tests revealed a prevalence of 0.077%, 0.083%, 0.102%, and 0.132%, respectively for HIV, HCV, HBV, and *Treponema pallidum*. Trends of hepatitis B and syphilis were decreasing; however, hepatitis C was increasing.

Conclusions: HIV and syphilis prevalence have been variable, with significant peaks in 2013 and 2014, respectively. Globally, the low rates reported in this study confirm the effectiveness of the preventive policy applied by the health authorities. However, among the rural population, special attention is required to stem any resurgence of hepatitis C and syphilis.

Key words: blood donors; blood safety; HIV; HCV; HBV; syphilis, Algeria.

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Introduction

Despite considerable advances in prevention and diagnosis, availability of treatment facilities and generalization of vaccination in several regions of the world, infectious diseases remain a major global challenge. Worldwide, approximately 37.7 million people were living with HIV at the end of 2020 with 1.5 million people becoming newly infected annually [1] and 5.6 million new cases of syphilis each year [2], while an estimated 354 million people worldwide live with hepatitis B or C [1]. On the other hand, blood transfusion saves millions of lives around the world each year, but this act is not without risks because any transfused patient is likely to contract a post-transfusion infection of viral, parasitic or bacterial origin [3,4]. Although mandatory screening has significantly reduced the prevalence of transfusion-transmitted infections (TTIs) worldwide, these infections still represent serious complications of blood transfusion leading to chronic and life-threatening disorders, mainly, by human immunodeficiency virus (HIV), viral hepatitis B and C, and syphilis. In addition, transfusion services in many countries face the challenge of ensuring sufficient and safe blood. In sub-Saharan Africa, for example, TTIs such as viral hepatitis B and C, AIDS and syphilis are widespread in the general population [3,4].

In Algeria, civil society is constantly called upon to mobilize for blood donation to ensure a sufficient national supply of blood and blood products. In 2019, blood collection increased by 9.4%, with at the same time an increase in blood transfusion centers across the national territory (National Blood Agency). Currently, Algeria is the leader of African countries for the availability of blood and its derivatives. For ten years, it has mobilized 13.98 donors per 1000 inhabitants on average, while the WHO objectives are barely 10 donors per 1000 inhabitants (National Blood Agency). Nevertheless, challenges remain significant in terms of the availability of this vital material, according to the required quality and safety standards; it is an integral part of universal health coverage and is a crucial

element of effective health systems. In 1991, the World Health Organization's Global AIDS Program and the International Federation of Red Cross and Red Crescent Societies published a consensus statement on screening for infectious agents transmissible by blood transfusion [5]. Effective screening for the most common and dangerous blood-borne agents can reduce the risk of transmission to very low levels. This is why it seemed interesting to undertake this present retrospective study on infectious risks for AIDS, viral hepatitis B and C and Syphilis in blood donors of Bejaia (Algeria), aiming to assess the post and pre-transfusion risk of these TTIs. We also aimed to determine epidemiological differences between urban and rural donors in the Bejaia province, during the period 2010-2019.

Methodology

Description and aims of the study

This study focused on blood donors originating from the province of Bejaia, those living in the city and the rural regions. It is a retrospective epidemiological and comparative study of the prevalence of AIDS, hepatitis B and C and syphilis. It was carried out in the serology laboratories of the blood transfusion center of Bejaia city and at the Khalil Amrane university hospital in Bejaia, in collaboration with the national blood agency. Its main objective is to assess the transfusion risks of the main infectious agents HIV, VHB and C and *Treponema pallidum* in blood donors and to compare the risk factors between the urban and rural populations of Bejaia province.

Study population and eligibility

From January 2010 to December 2019 (Ten years), all archived results from blood donors suitable for blood donation received at the blood transfusion unit of Bejaia and various blood transfusion stations in the Bejaia province were reviewed and included in this study. During data extraction, results from blood donors were divided into two groups: city dwellers, living in the city center and those living in rural areas. The following data were collected from the donor's tracking sheets: results for TTIs, age, gender, marital status, education degree, job/occupation and residency place. Donor eligibility was checked retrospectively before each blood donation and in total accordance with the WHO "Guidelines on Assessing Donor Suitability for Blood Donation". Data were collected in total respect of deontology rules, medical secret and patient's privacy. Collected data were de-identified and thus anonymity of the study subjects was upheld to its maximum.

Sampling and Screening protocol

The data are obtained from retrospective results collected by the transfusion units, applying the usual sampling and screening protocol for TTI agents and in accordance with WHO guidelines. Usually, the protocol consists of taking 50 ml of blood sample, divided into two tubes: a sterile tube without anticoagulant used for the serological analysis and an EDTA tube for the immunological analysis. Each sample was correctly labelled and accompanied by informative sheet and sent for detection of HIV p24Ag, anti-HIV1/2, HCVAg, anti-HCV, HBsAg and anti-*Treponema pallidum*. The 3rd generation indirect enzyme immunoassay technique (Bio-rad) was used, according to the manufacturer's recommendations. Reagents samples were subjected to verification tests. Confirmatory tests were performed by Western blot at Pasteur institute of Algeria.

Data processing

The Chi-squared test was performed to define statistically associated demographic factors. The association between the different factors and the risk of

Table 1. Yearly number, gender and positive cases of HIV, HCV, HBV and PT distribution among blood donors from Bejaia province (Algeria) in the period 2010 to 2019.

Year	Gender of blood donors		Total/Year	Positive cases				Total positive cases
	Men (%)	Women (%)		HIV	HCV	HBV	TP	
2010	9213 (77.74%)	2638 (22.26%)	11851	2	4	19	27	52
2011	10089 (81.13%)	2388 (19.20%)	12435	0	3	8	13	24
2012	9389 (76.93%)	2816 (23.07%)	12205	3	6	11	13	33
2013	9956 (76.52%)	3035 (23.33%)	13011	55	28	30	22	135
2014	11511 (76.47%)	3342 (22.20%)	15053	21	27	22	57	127
2015	12226 (80.51%)	2960 (19.49%)	15186	9	7	10	17	43
2016	11784 (79.11%)	3232 (21.70%)	14896	1	11	9	9	30
2017	11601 (79.59%)	2907 (19.97%)	14558	4	8	10	7	29
2018	12508 (83.48%)	2591 (17.29%)	14983	7	9	15	10	41
2019	13184 (82.97%)	2798 (17.61%)	15890	6	14	9	11	40
Total	**111461 (79.52 %)**	**28707 (20.48 %)**	**140168**	**108**	**117**	**143**	**186**	**554**

HIV: Human immunodeficiency virus; HCV: Hepatitis C virus; HBV: Hepatitis B virus; TP: *Treponema pallidum.*

infection was considered statistically significant for a P value <0.05. This test was also applied to compare between urban donors and those from bordering regions in terms of infectious risks.

Results

Demographic characteristics

During this retrospective study (2010-2019), we recorded 140168 blood donors in the province of Bejaia; the average number of donors was 14016 annually. This population included 28707 (20.48 %) women and 111461 (79.52 %) men (Table 1). The mean age was 31 (± 10) years and the majority of donors were younger than 39 years (59.40%), with more than a third between 30-39 years old. About half of the donors (54.21%) were married and 74.12 % were, at least with, a secondary education level. Labourers represented 26.23% of donors, meanwhile, functionary, self-employed, and housewives represented, respectively 16.97%, 16.06%, and 13.63%. The urban population represented 55.73% of total donors, while the rural population was 44.27% (Table 2).

Screening results and TTIs associated factors

During ten years, this retrospective study showed variability in TTIs prevalence within the population of Bejaia province. The overall prevalence of TTIs was 0.395%, with a total of 554 positive cases for 140168 blood donations. Relatively low rates, ranging from 0.193 to 0.438 %, were recorded during the 2010-2012 period. Then, a markedly high increase was observed between 2013 and 2015, with the highest rate of 1.03 % in 2013. Since 2016, a reduction in the number of cases was observed, with low rates that continued so until 2019 (Figure 1). Syphilis was the most common with 0.132 %, followed by hepatitis B, hepatitis C, and AIDS, with 0.102 %, 0.083 %, and 0.077 %,

Figure 1. Trends in the prevalence of human immunodeficiency virus (blue) and hepatitis C virus (red), hepatitis B virus (green) and syphilis (purple) in blood donors from urban (A), rural (B) and provincial (C) populations in Bejaia (Algeria), 2010-2019.

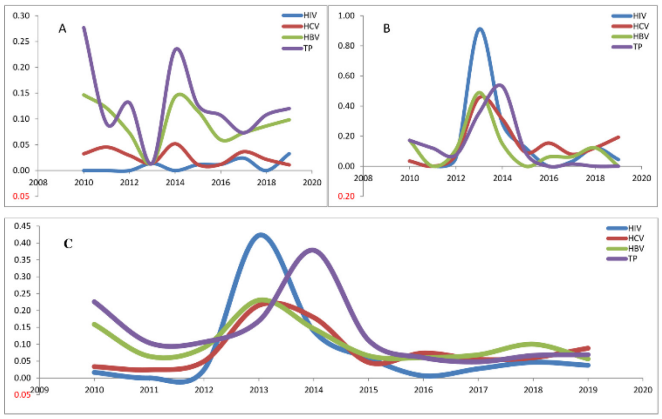


Table 2. Distribution of positive cases for HIV, HCV, HBV and PT among blood donors, from Bejaia province (Algeria) during the period 2010-2019.

	Urban population							Rural population							Whole provincial population						
Blood donors	**78123**							**62045**							**140168**						
Mean age (years)	**30.5 ± 10**							**32 ± 10**							**31 ± 10**						
	Total	**%**	**Positive cases**					**Total**	**%**	**Positive cases**					**Total**	**%**	**Positive cases**				
			HIV	**HCV**	**HBV**	**TP**	**Total**			**HIV**	**HCV**	**HBV**	**TP**	**Total**			**HIV**	**HCV**	**HBV**	**TP**	**Total**
Age																					
18-29	16562	21.20	1	6	18	7	32	12099	19.50	21	19	6	10	56	28661	20.45	22	25	24	17	88
30-39	31093	39.80	1	5	22	37	65	23515	37.90	37	21	16	33	107	54608	38.96	38	26	38	70	172
40-49	18515	23.70	4	7	21	36	68	13464	21.70	33	31	27	24	115	31979	22.81	37	38	48	60	183
50 or more	11953	15.30	2	2	11	18	33	12967	20.90	9	26	22	21	78	24920	17.78	11	28	33	39	111
Gender																					
Male	59530	76.20	5	9	39	40	93	51932	83.70	68	47	34	41	190	111461	79.52	73	56	73	81	283
Female	18593	23.80	3	11	33	58	105	10113	16.30	32	50	37	47	166	28707	20.48	35	61	70	105	271
Marital Status																					
Single	46093	59.00	4	7	37	21	69	29906	48.20	37	39	29	17	122	75998	54.22	41	46	66	38	191
Married	32030	41.00	4	13	35	77	129	32139	51.80	63	58	42	71	234	64170	45.78	67	71	77	148	363
Education degree																					
Illiterate	2891	3.70	1	7	15	22	45	7135	11.50	22	24	17	31	94	10026	7.15	23	31	32	53	139
Primary school	8750	11.20	1	2	26	17	46	12471	20.10	20	25	17	21	83	21221	15.14	21	27	43	38	129
Secondary school	22656	29.00	2	5	22	17	46	13836	22.30	19	19	13	14	65	36492	26.03	21	24	35	31	111
High school	22656	29.00	2	2	3	22	29	12285	19.80	27	18	9	7	61	34941	24.93	29	20	12	29	90
Graduate / Undergraduate	19531	25.00	1	3	3	11	18	13091	21.10	9	7	9	7	32	32622	23.27	10	10	12	18	50
Unknown	1641	2.10	1	1	3	9	14	3226	5.20	3	4	6	8	21	4867	3.47	4	5	9	17	35
Job/Occupation																					
Functionary	16718	21.40	3	1	10	21	35	7073	11.40	24	11	12	15	62	23791	16.97	27	12	22	36	97
Laborer	17656	22.60	1	6	22	25	54	19110	30.80	21	32	19	25	97	36766	26.23	22	38	41	50	151
Self employed	15937	20.40	2	4	17	21	44	6577	10.60	21	17	17	29	84	22514	16.06	23	21	34	50	128
Student	9609	12.30	0	1	3	7	11	7011	11.30	6	5	2	1	14	16620	11.86	6	6	5	8	25
Housewife	7812	10.00	1	3	11	16	31	11292	18.20	15	16	11	12	54	19104	13.63	16	19	22	28	85
Jobless	8984	11.50	1	3	5	5	14	8376	13.50	12	13	8	2	35	17360	12.39	13	16	13	7	49
Unknown	1406	1.80	0	2	4	3	9	2606	4.20	1	3	2	4	10	4012	2.86	1	5	6	7	19
Total positive cases			8	20	72	98	**198**			100	97	71	88	**356**			108	117	143	186	**554**

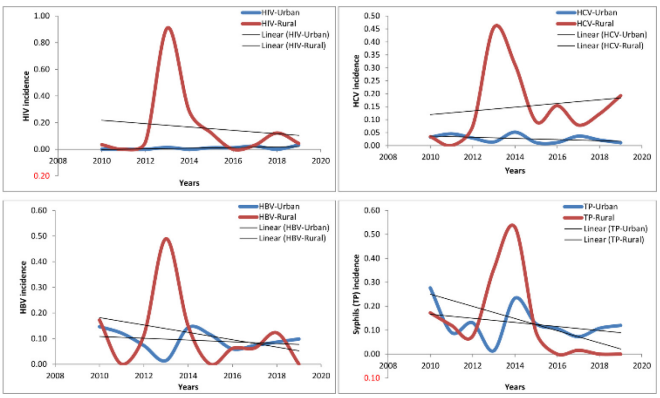
HIV: Human immunodeficiency virus; HCV: Hepatitis C virus; HBV: Hepatitis B virus; TP: *Treponema pallidum.*

respectively. Donors over 40 years of age (incidence: 0.572%) compared to other categories (0.307% [18-29]; 0.314% [30-39] and 0.445% [≥ 50]. Concerning marital status and gender, married donors(incidence: 0.565%), and female donors (incidence: 0.944%) were the most at risk ($p < 0.0001$)for positive serology, compared to single (0.251%) and male (0.253%), respectively. In addition, self-employment and illiteracy were likely associated with positive serology ($p < 0.0001$), with rates of 0.568 % and 0.138 %, respectively

Comparative analysis: urban vs. rural population

Of the 140,168 donors, 78,123 (55.73%) were inhabitants of the city of Bejaia, considered urban population. The population of the neighbouring regions, considered as rural, numbered 62,045 (with 44.27%) donors (Table 2). The rural population was more likely to be positive for one of the 4 TTIs studied, with an overall rate of 0.57%, unlike the urban population, with 0.25 % ($p < 0.0001$). Regarding the type of TTI agent, rural donors are more significant to be HIV positive, with an incidence of 0.16%, and HCV positive with 0.15 % ($p < 0.0001$), whereas, within the urban population, these rates are 0.01% and 0.02%, respectively. However, no difference was observed in rural and urban populations, for hepatitis B ($p = 0.195$) and Syphilis ($p = 0.403$). A difference is also observed between these two populations concerning the evolution of the 4 TTI incidences during the decade. Within the urban population, variation was relatively slight over the years, while in the rural population, this variation was marked by a high peak between 2013 and 2015. Then, the incidence decreased from 2016 and stabilized until 2019 (Figure 1). Within the two studied populations, a decrease was observed for hepatitis B and Syphilis. However, the hepatitis C rate is increasing in recent years among the rural population. AIDS evolution remains constant among the urban population, while decreasing in the rural population (Figure 2).

Figure 2. Evolution of Human immunodeficiency virus (HIV), Hepatitis C virus (HCV), Hepatitis B virus (HBV) and Treponema pallidum (TP) incidences over ten years period (2010-2019) in urban (blue) and rural (red) populations in the province of Bejaia (Algeria).



Discussion

Algeria is a country in North Africa located at the crossroads of two areas strongly affected by AIDS and other sexually transmitted diseases that are Europe and sub-Saharan Africa. It faces waves of sub-Saharan migration to Europe, typically young people from poor countries with around half of people living with HIV globally [6].On the other hand, a large community of young people living in Europe, vulnerable and often marginalized, move by thousands and among them carriers of several transmissible diseases. This community could participate in the spread of sexually transmitted and transfusion-related infections [7]. This is, to our knowledge, the first study in Algeria focused on TTIs infections. Nevertheless, it is limited by some missing data, mainly the cases of co-infection, other co-morbidities, type, number, and frequency of donation etc. Our objectives were to report the prevalence of TTI among blood donors in the province of Bejaia and to carry out a comparative study between urban and rural populations. We found that the majority of donors are male, which is consistent with what was reported in several studies. This is due to gynaecological and physiological factors that do not allow women to donate blood as frequently as a man, such as menstrual cycles, pregnancy, and breastfeeding [8,9]. The average age of donors is 31 years, very close to that reported by Yeldiz *et al.* [8]. However, the marital status of donors is different from what was described by Kebede *et al.* [10] with more than half of married donors.

On the overall population of donors, 554 (0.395%) were positive for, at least, one of the four TTIs agents. This prevalence is much lower than what was reported in Tanzania, with a rate above 10%, and in many other African countries [9]. In addition, this rate is lower compared to what has been reported in Turkey [8] and it remains rather close to that described in Serbia [11]. According to the WHO, these rates correspond to what is reported by Upper middle-income countries [12]. It is undeniable that these low rates are due to the success of the government policy-making vaccination, when possible, mandatory from childhood and which ensures free vaccines and treatment in Algeria.

A significant variation was observed over the 10 years of the study, with a peak of 1.03% in 2013 for the

4 TTI. During this period, a marked improvement in the living conditions of citizens was recorded. An opening of the national youth to the outside world as well as the use of narcotics would very probably be the origin of the appearance and the propagation of diseases transmitted by sex and blood. We have noticed that syphilis is the most common in the population. This can be explained by a significant lack of sex education and the latency of the disease, which can remain asymptomatic for several years [13]. However, in the only related study on this subject, dealing with HIV in pregnant women (Annaba, eastern Algeria), syphilitic serology was 0.26% [7]. Compared to our study, the prevalence of syphilis in women is 0.37%, a relatively worrying increase. Moreover, we found female gender seemed more at risk for positive serology ($p < 0.0001$), which differs from findings elsewhere, describing high rates in the male gender [10,13]. This result is indicative of a particular need to improve the management and prevention of this disease in women. Hepatitis B and C prevalences recorded in this study are very low and constitute a positive sign. Thus, according to the Global Hepatitis Report, approximately 257 million people were living with chronic HBV infection and 71 million people with chronic HCV infection in 2015 [12]. On the continental level, results reported by the survey conducted in 11 African countries between 2009 and 2012 are higher than ours, with a positivity rate of 6.2% for HBV and 1.6 for HCV [4]. The epidemic caused by HBV affects mostly the WHO African Region and the Western Pacific Region. The WHO Eastern Mediterranean Region and the European Region have the highest reported prevalence of HCV [12]. These relatively low rates can be explained by two main factors. The first is the low incidence of HIV in the Algerian population, reducing cases of HBV/HIV and HCV/HIV co-infection. The second is the policy of compulsory vaccination against hepatitis B from childhood and of booster vaccination for populations at risk, in adulthood, such as dialysis patients and health practitioners. There was a statistically significant difference in the prevalence of infections with any of the 4 TTIs agents, depending on the subjects' education levels and occupations. This finding is similar to what was reported in Turkey [8] and Iran [14].

Compared to the urban, the rural population is more exposed to the risk of infection by one of the 4 TTI. Several factors may explain these results, including the low level of education, socio-economic precariousness, lack of medical care in these inaccessible regions, as well as non-compliance with the national vaccination plan. HIV and HCV were significantly more common in rural donors. In addition to the above factors, lack of treatment, absence of vaccination, and unavailability of screening and diagnosis means, make these two diseases spread effectively among vulnerable populations distant from healthcare facilities. Our results are completely different from those reported by de Castro Rocha and collaborators, with high syphilis and HBV prevalence among populations from low-income areas, in Brazil [15]. The incidence evolution of the 4 TTIs agents, within donors of the two populations is globally encouraging, since a discontinuous decrease is observed, except for HCV, which seems to be rising in the rural population.

Conclusions

TTIs prevalence in blood donors is indicative of the overall incidence in a population and provides important epidemiological information. This study is the first of its kind to explore the prevalence of blood-borne infections and associated risk factors in Bejaia's population, in Algeria. Moreover, this is the first study to draw a comparative report between urban and rural populations. As a first conclusion, the incidence rates of HIV, HBC and syphilis confirms the effectiveness of the preventive health policy applied by the health authorities. However, increased surveillance for HCV seems essential within the population. Prevalence rates reported in this study are close to what is expected in upper-middle-income countries. Secondly, the demographic factors revealed the categories of populations vulnerable to TTIs as well as the high risk for the rural population, in particular for HCV and syphilis. Female gender, married donors, age over 40, illiteracy and self-employment seem to be factors associated with positive serology. The government's policy, of providing compulsory vaccination from childhood and ensuring free healthcare for the entire population, would be the main factor behind this positive situation. However, among the rural population, special attention is needed to stem any resurgence of hepatitis C and to reduce the syphilis rate in this region. The epidemiological surveillance of these four infections in our country is based on voluntary, anonymous and free screening, which should be compulsory, for prevention.

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Authors' Contributions

Conceptualization and methodology: F. Djoudi and MT Chouikh; formal analysis and investigation: N Amir; writing and original draft preparation: F Djoudi and N Amir

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Corresponding author

Ferhat Djoudi, PhD
Laboratoire d'Ecologie Microbienne
Université de Bejaia, Route de Targa-Ouzemour
Bejaia 06000, Algérie.
Tel: +213774168506
Fax: +21334813710
Email: ferhat.djoudi@univ-bejaia.dz
ORCID: 0000-0002-0614-7076

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