

Sero-prevalence and associated factors of syphilis among blood donors in Debre Marko's blood Bank Northwest Ethiopia

Awoke Abebe² , Getu GIRMAY² , Eden WOLDEGERIMA⁴ , and Debaka BELETE³ 

¹University of Gondar, College of Medicine and Health Sciences, School of Biomedical and Laboratory Sciences, Department of Medical Microbiology, Gondar, Ethiopia

²Debre Tabor University, College of Health Sciences and school of Medicine Department of Medical Laboratory Debre tabor, Ethiopia

³University of Gondar, College of Medicine and Health Sciences, School of Biomedical and Laboratory Sciences, Department of Immunology and molecular biology, Gondar, Ethiopia

⁴University of Gondar, Institutes of Biotechnology, Department of Medical Biotechnology, Gondar, Ethiopia

✉Corresponding author's Email: debakab21@gmail.com

ABSTRACT: Several infectious diseases have been found to be associated with transfusion of blood and blood components. From those, syphilis is a sexually and transfusionally transmittable disease that is caused by *Trepanoma pallidum*. *Trepanoma pallidum* is one of the oldest recognized infectious risks of blood transfusion and poses a challenge to the safety of the blood supply. Therefore, the aim of this study is to determine the sero-prevalence and associated factors of syphilis among blood donors in Debre Marko's blood bank, Northwest Ethiopia. A Hospital-based cross-sectional study was conducted from February 1 – April 30/2021. The socio-demographic data and associated factors were collected using a structured questionnaire and blood samples were collected by convenient sampling technique and tested for anti-syphilis Ab: using DIALAB ELISA (Nora Kampitsch, MSc, India). The data was coded, cleaned, and analyzed by SPSS version 23. The binary logistic regression model was used to investigate factors associated with syphilis. A p-value of < 0.05 at multivariable analysis was considered statistically significant. Among 223 participants, the prevalence of Syphilis infections was 7 (3.13 %). Those blood donors with unsafe sex (AOR= 5.34; 95%CI: 1.87–27.5), aged of ≥35 years (AOR = 3.5; 95% CI: 1.3- 17.4) and number of donation (AOR = 3.87; 95%CI: 1.08-11.9) were significantly associated with Syphilis infections. In this study, the sero-prevalence of syphilis infection was 3.13%. Factors such as practice unsafe sex, age and number of donations were significantly associated with syphilis infections. Improvement in monitoring, surveillance and evaluation of transfusion-transmitted infections and sexually transmitted infections is very important. In addition to the rapid tests and ELISA, more sensitive assay methods like polymerase chain reaction (PCR) should be included in future prospective studies with large sample size to screen for syphilis infections.

KEYWORDS: Syphilis, blood donors, Debre-markose Ethiopia

INTRODUCTION

Blood transfusion is an effective treatment for saving millions of lives worldwide each year. However, unsafe transfusion leads to many life-threatening complications and increases the possibility of transfusion-transmitted infections [1]. Among these, the bacterial pathogen *Treponema pallidum* is a spirochete responsible for the disease known as syphilis. Congenital syphilis is transmitted through the placenta or a hematogenous route like blood transfusion, while acquired syphilis mostly spreads through sexual contact and affects the genital and anal areas [2].

The World Health Organization (WHO) recommended quality-assured screening for TTIs, including HIV, HBV, HCV, and syphilis, on all considering blood; the Ethiopian government followed this recommendation to ensure the accessibility of safe components and safe blood and related products [3]. Accordingly, continuous evaluation of the burden of TTIs in blood donors is significant for estimating the risk of transfusion and enhancing donor selection strategies to reduce infectious diseases transmission [4]. Blood donation in high-risk groups is a threat to blood

safety. It is a matter of concern whether the high-risk group of blood donors is effectively excluded from the health consultation before blood donation. The risk factors for blood donors infected with syphilis are also risk factors for other blood borne diseases [5]. In many parts of the world, the incidence and prevalence of syphilis still remain high in both volunteer and family/replacement blood donors [6-9]. There are numerous reports in high-risk groups in the literature, both from developed and developing countries, indicating rising prevalence and incidence of syphilis [10-12].

Even though, there are few epidemiological studies conducted in donors [13, 14]. Generally, despite the fact that several studies have been published on the prevalence of Syphilis infections among various risk groups, there is a study limitation about Syphilis prevalence among blood donors that shows healthy blood donors and high-risk group blood donors at the national and institutional levels, which is used for estimating the risk of transfusion and optimizing donor recruitment strategies to minimize blood-borne infectious disease transmission, particularly AIDS. Additionally, many studies in Ethiopia have TTIs among its blood; most of them are retrospective. Also, due to the lack of understanding, the unavailability of screening tests, limited access to health facilities, and the unavailability of surveillance systems, the accurate figures of TTIs in our population are still unknown, particularly in this study area.

Therefore, the aim of this study was to determine the sero-prevalence of syphilis among voluntarily blood donors at Debre Markos Blood Bank, Northwest Ethiopia.

MATERIALS AND METHODS

Study design, area, and period

An intuition-based cross-sectional study was conducted in Debre Marko's blood bank, North-West Ethiopia, from February 1–April 30/2021. Debre Markos is the capital of the East Gojjam zone, which is 295 km northwest of Addis Ababa, the capital city of Ethiopia, and 264 km southeast of Bahir Dar, the capital city of Amhara National Regional State. The city has 11 administrative kebeles, and the population size is estimated to be 111,313 in 2018 [15], of which 51,358 are males. There are four public health centers, one comprehensive specialized hospital, and one blood bank that provide general health care service and higher levels of clinical care for catchment populations.

Source and study population

The source population was all voluntary blood donors visiting Debremarkos blood bank, while all blood donors who were prospectively recruited in the study during the study period. To include blood donors who were eligible for donation, consented, interviewed, and gave blood for screening of TTIs, the convenient sampling technique was used. All participants who fulfilled the national and regional blood bank criteria were included and those who did not meet the inclusion criteria (65 years, and unwillingness to give informed consent) were excluded from the study.

Data collection

Socio-demographic characteristics and clinical factors

After obtaining informed consent, a pre-tested structured questionnaire was given to eligible blood donors for an interview in order to gather socio-demographic data, including information on the sex, age, occupation, place of residence, marital status, level of education, and other details on potential risk factors for the transmission of syphilis, such as history. Multiple sexual partners, intravenous drug use, history of practice of unprotected sex, and history of alcohol use.

Specimen collection and processing

From each blood donor, five milliliters of venous blood were collected by laboratory technologists and left for 30 minutes to aid in clotting. Then serum was separated, and the blood samples were centrifuged for five minutes at room temperature at a speed of 3000 revolutions per minute. The leftover serum was separated, collected, and

kept at room temperature; to identify syphilis of blood donors ELISA serological method was applied during the study period. The serum samples were screened for syphilis by using WANTAI anti-TP ELISA (Bejieng Wantai biological pharmacy). All tests were performed according to the manufacturer's instructions.

Data quality control

The questionnaire was initially written in English, then translated into Amharic, and finally returned to English. This was carried out to preserve simplicity, completeness, and clarity. Prior to the study, 5% of the questionnaire was pretested. It was evaluated on how long it took to complete the questionnaire and how each question flowed and was clear and easy to understand. The principal investigator regularly verified the accuracy of all the data collected. Finally, we checked the collected data, cleaned it manually, and entered SPSS version 23 for analysis.

Laboratory quality control

All specimens were collected and processed according to the standard operating procedure (SOP). The quality of the specimens was checked to see if they meet the acceptable criteria like clotting and volume. The samples were tested according to the manufacturer's instructions, and all quality issues were maintained by following the SOP for the detection of anti-syphilis antibodies. The quality of the test result was maintained by using internal quality control of the ELISA and by using known negative and positive samples.

Data processing and analysis

All participants' information and laboratory data were entered and then analyzed using SPSS version 23. The prevalence of syphilis infection was analyzed using frequency analysis.. Bivariate logistic regression was done to determine predictors of syphilis infections by calculating the odds ratio (OR). The Hosmer-Lemeshow goodness-of-fit test was used to assess the fitness of the model. The multivariable logistic regression model was then applied to the variables having a p-value of less than or equal to 0.2 in the bivariate, and the adjusted odds ratio (AOR) for those variables was obtained. Variables with p-values less than 0.05 were considered statistically significant.

RESULTS

Socio-demographic characteristics of blood donors

A total of 223 blood donors participated in the study. All of them were consented, interviewed, and provided clinical samples. The age of the blood donors ranges from 18 to 65 years. From total of participants, majority (73.8%) of them were found in age group of 25-34 years old. The majority of the study subjects, 122 (54.7%) were female, and 181 (81.2%) were from urban areas. Most of the study participants were married, 178 (79.8%), and one-third, 76 (34.0%) of blood donors were secondary school. One hundred two (45.7) of the study participants were government workers, and 80 (35.9%) were self-employed (Table 1).

Behavioral and clinical characteristics of blood donors

A total of 27 (12.1) participants had a history of multiple sexual partners. Among participants, 23 (10.3%) had a history of alcohol use, 3(1.3%) had a history of intravenous drug users, 15 (6.7%) had a history of sharing sharp materials, and 14 (6.3%) had a history of practicing unsafe sex (Table 2).

Sero-prevalence and associated factors of syphilis

The overall prevalence of syphilis among blood donors who participated in this study was 7/223 (3.13%) and the positivity was higher in male participants at 5/101(5.0%). The prevalence of syphilis was higher among blood donors aged greater than 35 years 3/39 (7.6%). Regarding the marital status, a high prevalence was observed among blood donors within single, which showed 3/42 (7.1%). Among occupational status the highest prevalence of syphilis was observed among unemployed 2/36(5.5) and 6/175(3.4%) resident in urban were infected with syphilis. According to this study, the sero-prevalence of syphilis increased 2/14(14.3%) among blood donors who

had a practice of unsafe sex (Table 3).

Table 1. Socio-demographic characteristics of blood donors in Debre Marko's blood Bank Northwest Ethiopia.

Socio-demographic variables		Frequency (N)	Percentages (%)
Sex	Male	101	45.3
	Female	122	54.7
Age group	18-24	41	18.4
	25-34	142	63.7
	>=35	40	17.9
Marital status	Single	42	18.8
	Married	178	79.8
	Divorced	2	0.9
	Widowed	1	0.4
Residency	Urban	181	81.2
	Rural	42	18.8
Educational status	Unable to read and write	29	13
	Primary school	63	28.3
	Secondary school	76	34
	College and above	55	24.7
Occupation	Governmental	102	45.7
	Private work	80	35.9
	Farmer	3	1.4
	Unemployed	38	17

Table 2. Behavioral and clinical characteristics of blood donors in Debre Marko's blood Bank Northwest Ethiopia.

Variables	Category	Frequency (N)	Percentages (%)
Multiple sexual partners	Yes	27	12.1
	No	196	87.9
Sharing sharp materials	Yes	15	6.7
	No	208	93.3
Practice unsafe sex	Yes	14	6.3
	No	209	93.7
Alcohol user	Yes	23	10.3
	No	200	89.7
Intravenous drug use	Yes	3	1.3
	No	220	98.7
Blood donation	First	127	57
	Second	96	43

Table 3. Sero-Prevalence of syphilis infection regarding socio-demographic s, behavioral and clinical characteristics of blood donors at DebreMarkose blood bank, North west Ethiopia

Variables		Syphilis + status n% / N	COR (95%CI)	P- value	AOR (95%CI)	P-value
Sex	Male	5/101(5.0%)	1.12 (0.87–4.1)	0.73	0.65(0.53–4.5)	0.82
	Female	2/115(%)	1			
Age	18-24	1/39(2.6%)	1	0.16	1	0.15
	25-34	3/138(2.1%)	2.1(0.35-9.12)			
	≥35	3/39(7.6%)	6.5(2.70-21.3)			
Residency	Urban	6/175(3.4)	1.32 (0.14–11.1)	0.54	1.02(0.03–9.2)	0.73
	Rural	1/41(2.4)	1			
Educational	Unable to read and write	0/27(0.0%)	1	0.015*	2.05(1.01-13.2)	0.32*
	Primary school	2/61(3.3%)	3.26(1.1-13.3)			
	Secondary school	4/73(5.4%)	0.55(0.14-2.3)			
	College and above	1/55(1.8%)	2.3(1.7-13.7)			
Practice unsafe sex	Yes	2/14(14.3%)	6.2 (2.3–19.2)	0.015*	5.34(1.87–27.5)	0.023*
	No	5/209(2.4%)	1			
Alcohol user	Yes	3/23(13.0%)	3.63(1.2-8.3)	0.65	1.41(0.35-5.72)	0.377
	No	4/200(2.0%)	1			
Blood donation	First time	6/127(4.7%)	4.16(1.03-7.7)	0.23*	3.87(1.08-11.9)	0.042*
	Repeated donators	1/96(1.04%)	1			

*Significant values. Abbreviations: COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval

DISCUSSION

Blood transfusion is considered to be a potential risk factor for the transmission of blood-borne infections such as HBV, HCV, HIV, and syphilis, which are the greatest threats to blood safety for the recipient. The current study tried to show the sero-prevalence of syphilis among blood donors at DebreMarkose Blood Bank, Ethiopia. In the current study, the overall sero-prevalence of syphilis was 7(3.13 %) which is comparable to studies in Ethiopia 3.4% [16] and Burkina Faso 3.96% [17]. on the other hand, our study finding is higher to previous studies conducted in different parts of countries like 0.8% in Hawassa [18] 0.74% in Debre Tabor [19], the 0.71% in North Shoa [20], the 0.6% in Eritrea [21], 1.3% in Gondar [22], 1.2% in Bahir Dar [23], 1.45% in India [24], and 1.56% in Kenya [25].

The possible reasons for the discrepancy in the total sero-prevalence of syphilis between various studies could be variation in the total sample size, in the nature of the study population, research method used, time period, the test kits on the market, storage, and validation of the test kits. different geographical area . However, it is lower than previous reports like 7.9% in Wolaita Sodo [26] and 8.1% in Cameroon [27]. Variation observed in sero-prevalence may be attributed to differences in geographical setting, sample size, and use of different methods for testing. In this study, the blood donors within the age group ≥35 years (AOR = 3.5; 95% CI: 1.3- 17.4) were significantly associated with Syphilis infection compared to those at the age of 18–24 years. This result was similar with study conducted in different countries [16, 21, 23, 28–30]. However, our result was not inconsistent study conducted in our country like in Jigjig [31].

Our study showed that Practice unsafe sex (AOR= 5.34; 95%CI: 1.87–27.5) were significantly associated with syphilis infection. This finding is consistent with studies conducted in China [32, 33] and Indonesia [34]. The key mode of acquiring sexual transmitted infection in Africa is sexual activity, multiple partners being one of the main risk factors. The current study also showed that those blood donors who donated blood for the first time or new blood donors (AOR = 3.87; 95%CI: 1.08-11.9) were more likely to have Syphilis infection compared to those regular (repeat) types of blood donors. Similar findings have been reported from Bahir Dar [23] and Kenya [35]. This might be directly associated with the post-donation counseling service. There are individuals who have wrong perceptions of donating blood as a method of knowing their own status regarding TTIs and continuing their life as normal if

they are not informed that this will in turn increase the transmission of TTIs among the general population by one or other means.

CONCLUSIONS AND RECOMMENDATIONS

In this study, the sero-prevalence of syphilis infection was 3.13%. Improvement in monitoring, surveillance and evaluation of transfusion-transmitted infections and sexually transmitted infections is very important. Promoting awareness creation regarding blood transfusion transmission of syphilis infection and early uptake of syphilis screening test used to help reduce transfusion transmissible syphilis infection burden observed among blood donors. Health education about modes of transmission and screening should be introduced during regular blood donor. In addition to the rapid tests and ELISA, more sensitive assay methods like polymerase chain reaction (PCR) should be included in future prospective studies with large sample size to screen for syphilis infections.

Limitation of the Study

The diagnostic tool used in this study use of serological and it would be better if like polymerase chain reaction (PCR) techniques had been used. Therefore, the results reported in this study may under estimate (presence of a window period) the frequency of syphilis infection among donors in this population. Additionally, the study depends on self-reported data for variables such as sexual behavior, which introduces the possibility of reporting bias or social desirability bias, thereby potentially compromising the accuracy of the results.

DECLARATIONS

Corresponding author

Correspondence and requests for materials should be addressed to Debaka Belete; E-mail: debakab21@gmail.com; ORCID: <https://orcid.org/0000-0002-4133-7481>

Ethical approval and consent to participants

Before the commencement of the study, we obtained ethical clearance from the Debre Tabor University, College of Health Sciences and Department of Medical Laboratory Science, Research Ethics Committee (REC) (Ref. No. CMH/261/2021). A letter of support was written to the Debre Markose blood bank to obtain their cooperation, and the study was secured at all levels. Written informed consent was obtained from each study participant, and confidentiality was maintained at each level of the study using code numbers for identification.. We conducted the study following the Declaration of Helsinki [36].

Availability of data and material

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

Author's contributions

A. Abebe: conception and design of the work, data acquisition, analysis, and interpretation. E. Woldegerima, G. Girmay, and D. Belete conception and design of the work, data acquisition, and analysis, drafting the manuscript, revising the manuscript; E. Woldegerima,, A. Abebe;, G. Girmay, and D. Belete: data interpretation, manuscript revision, and supervision. All authors reviewed the manuscript.

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Competing interests

The authors declare that they have no competing interests in this work.

REFERENCES

1. Arshad A, Borhany M, Anwar N, Naseer I, Ansari R, et al. Prevalence of transfusion transmissible infections in blood donors of pakistan. 2016; 16: 1-6.
2. Gomes NCRC, Meier DAP, Pieri FM, Alves E, Albanese SPR, et al. Prevalence and factors associated with syphilis in a reference center. 2017; 50 (01): 27-34.
3. Organization WH. Blood donor selection: Guidelines on assessing donor suitability for blood donation. 2012. World Health Organization;
4. Tessema B, Yismaw G, Kassu A, Amsalu A, Mulu A, et al. 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. 2010; 10: 1-7.
5. Liu S, Luo L, Xi G, Wan L, Zhong L, et al. Seroprevalence and risk factors on syphilis among blood donors in chengdu, china, from 2005 to 2017. 2019; 19: 1-8.
6. Liu J, Huang Y, Wang J, Guo N, Li J, et al. The increasing prevalence of serologic markers for syphilis among chinese blood donors in 2008 through 2010 during a syphilis epidemic. 2012; 52 (8): 1741-1749.
7. Zou S, Notari EP, Fang CT, Stramer SL and Dodd RYJT. Current value of serologic test for syphilis as a surrogate marker for blood-borne viral infections among blood donors in the united states. 2009; 49 (4): 655-661.
8. Mogtomo MLK, Fomekong SL, Kuete HF and Ngane ANJCdédérFS. Screening of infectious microorganisms in blood banks in douala (1995-2004). 2009; 19 (1): 3-8.
9. Ji Z-H, Li C-Y, Lv Y-G, Cao W, Chen Y-Z, et al. The prevalence and trends of transfusion-transmissible infectious pathogens among first-time, voluntary blood donors in xi'an, china between 1999 and 2009. 2013; 17 (4): e259-e262.
10. Pathela P, Braunstein SL, Schillinger JA, Shepard C, Sweeney M and Blank SJJJoAIDS. Men who have sex with men have a 140-fold higher risk for newly diagnosed hiv and syphilis compared with heterosexual men in new york city. 2011; 58 (4): 408-416.
11. Salado-Rasmussen K, Katzenstein TL, Gerstoft J, Cowan SA, Knudsen TB, et al. Risk of hiv or second syphilis infection in danish men with newly acquired syphilis in the period 2000–2010. 2013; 89 (5): 372-376.
12. Hao C, Yan H, Yang H, Huan X, Guan W, et al. The incidence of syphilis, hiv and hcv and associated factors in a cohort of men who have sex with men in nanjing, china. 2011; 87 (3): 199-201.
13. Deressa T, Birhan W, Enawgaw B, Abebe M, Baynes HW, et al. Proportion and predictors of transfusion-transmissible infections among blood donors in north shewa zone, central north ethiopia. 2018; 13 (3): e0194083.
14. Ataro Z, Urgessa F and Wasihun TJEjohs. Prevalence and trends of major transfusion transmissible infections among blood donors in dire dawa blood bank, eastern ethiopia: Retrospective study. 2018; 28 (6).
15. Mekuriaw T and Gokcekus HJECER. The impact of urban expansion on physical environment in debre markos town, ethiopia. 2019; 11: 16-26.
16. Heyredin I, Mengistie B and Weldegebreal F. Sero-prevalence of transfusion-transmittable infections and associated factors among blood donors in eastern ethiopia: An institutional-based cross-sectional study. SAGE open medicine. 2019; 7: 2050312119834468.
17. Nagalo MB, Sanou M, Bisseye C, Kaboré MI, Nebie YK, et al. Seroprevalence of human immunodeficiency virus, hepatitis b and c viruses and syphilis among blood donors in koudougou (burkina faso) in 2009. Blood transfusion. 2011; 9 (4): 419.
18. Bonja F. 2015. Prevalence of transfusion transmitted infections among blood donors at yirgalem hospital and hawassa blood bank center, sidama zone, snnprrs, ethiopia [Thesis type]: Addis Ababa University.
19. Berhanu S, Abebaw S and Digissie A. Transfusion-transmissible infections among voluntary blood donors at debre tabor blood bank, north west ethiopia: A three years retrospective study. Health Care Curr Rev. 2018; 6 (4): 2.
20. Tekalign Deressa TD, Wubet Birhan WB, Bamlaku Enawgaw BE, Molla Abebe MA, Baynes H, et al. Proportion and predictors of transfusion-transmissible infections among blood donors in north shewa zone, central north ethiopia. 2018.
21. Siraj N, Achila OO, Issac J, Menghisteb E, Hailemariam M, et al. Seroprevalence of transfusion-transmissible infections among blood donors at national blood transfusion service, eritrea: A seven-year retrospective study. BMC infectious diseases. 2018; 18: 1-9.
22. Tessema B, Yismaw G, Kassu A, Amsalu A, Mulu A, et al. 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. 2010; 10: 1-7.
23. Shiferaw E, Tadiolo W, Melkie I and Shiferaw M. Sero-prevalence and trends of transfusion-transmissible infections among blood donors at bahir dar district blood bank, northwest ethiopia: A four year retrospective study. PloS one. 2019; 14 (4): e0214755.
24. Pathak C and Sehgal S. Evaluation of the seroprevalence of transfusion transmissible infections among blood donors in a tertiary care hospital of north india. Iranian Journal of Blood and Cancer. 2016; 8 (1): 13-16.
25. Onyango CG, Ogonda L, Guyah B, Okoth P, Shiluli C, et al. Seroprevalence and determinants of transfusion transmissible infections among voluntary blood donors in homabay, kisumu and siaya counties in western kenya. BMC research notes. 2018; 11: 1-6.
26. Bisetegen FS, Bekele FB, Ageru TA and Wada FW. Transfusion-transmissible infections among voluntary blood donors at wolaita sodo university teaching referral hospital, south ethiopia. Canadian Journal of Infectious Diseases and Medical Microbiology. 2016; 2016 (1): 8254343.
27. CE EM, EG ES, Mbangue M and Lehman L. Hiv, hbv, hcv and t. Pallidum infections among blood donors and transfusion-related complications among recipients at the laquintinie hospital in douala, cameroon. BMC Hematology. 2014; 14 (1): 5-5.
28. Adu-Poku F, Agboli E and Tarkang EE. Seroprevalence of transfusion-transmissible infections among blood donors in the hohoe municipality hospital, ghana: 2015-2016: A retrospective hospital-based cross-sectional study. PAMJ-Clinical Medicine. 2020; 2 (12).

29. Tafesse TB, Gebru AA, Gobalee S, Belay GD, Belew MT, et al. Seroprevalence and diagnosis of hiv, hbv, hcv and syphilis infections among blood donors. *Human antibodies*. 2016; 25 (1-2): 39-55.
30. Teklemariam Z, Mitiku H and Weldegebreal F. Seroprevalence and trends of transfusion transmitted infections at harar blood bank in harari regional state, eastern ethiopia: Eight years retrospective study. *BMC Hematology*. 2018; 18: 1-8.
31. Mohammed Y and Bekele A. Seroprevalence of transfusion transmitted infection among blood donors at jijiga blood bank, eastern ethiopia: Retrospective 4 years study. *BMC research notes*. 2016; 9: 1-6.
32. Zhang C, Li X, Su S, Zhang L, Zhou Y, et al. Prevalence of hiv, syphilis, and hcv infection and associated risk factors among male clients of low-paying female sex workers in a rural county of guangxi, china: A cross-sectional study. *Sexually transmitted infections*. 2014; 90 (3): 230-236.
33. Hu Q-h, Xu J-j, Zou H-c, Liu J, Zhang J, et al. Risk factors associated with prevalent and incident syphilis among an hiv-infected cohort in northeast china. *BMC infectious diseases*. 2014; 14: 1-10.
34. Pisani E, Girault P, Gultom M, Sukartini N, Kumalawati J, et al. Hiv, syphilis infection, and sexual practices among transgenders, male sex workers, and other men who have sex with men in jakarta, indonesia. *Sexually transmitted infections*. 2004; 80 (6): 536-540.
35. Mahuro G, Gichangi P, Mwangi C and Kipkorir N. Seroprevalence of hepatitis b, hepatitis c, human immunodeficiency virus and syphilis in donated blood in kenya, 2016: Situation analysis. *J Blood Disord Transfus*. 2017; 8 (4).
36. Abate E, Belayneh M, Idh J, Diro E, Elias D, et al. Asymptomatic helminth infection in active tuberculosis is associated with increased regulatory and th-2 responses and a lower sputum smear positivity. *PLoS neglected tropical diseases*. 2015; 9 (8): e0003994.

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