Detection of acute and chronic toxoplasmosis amongst multi-transfused thalassemia patients in southwest of Iran

Elham Yousefi\textsuperscript{1,2}, Masoud Foroutan\textsuperscript{1,3*}, Roya Salehi\textsuperscript{4}, Shahram Khademvatan\textsuperscript{4,5*}

\textsuperscript{1}Student Research Committee, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
\textsuperscript{2}Department of Medical Parasitology and Mycology, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
\textsuperscript{3}Department of Parasitology, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran
\textsuperscript{4}Cellular and Molecular Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
\textsuperscript{5}Cellular and Molecular Research Center & Department of Medical Parasitology and Mycology, Urmia University of Medical Sciences, Urmia, Iran

ARTICLE INFO

Objective: Since pre-transfusion screening for \textit{Toxoplasma gondii} is not performed on blood packs, thalassemia patients are susceptible to acquiring toxoplasmosis; thus, the aim of this study was to evaluate the seroprevalence status of \textit{T. gondii} in individuals who suffer from thalassemia in comparison to healthy persons in the southwest of Iran.

Methods: In this case-control study, 117 thalassemia patients and 205 healthy persons participated. All samples were tested for the presence of specific IgG and IgM antibodies against \textit{T. gondii} using ELISA technique. Data were analyzed using Chi-square test. 

Results: Seroprevalence of anti-\textit{T. gondii} IgG was detected in 30.76\% (36/117) of patients and 20\% (41/205) of healthy individuals (\(P=0.04\)), also anti-\textit{T. gondii} IgM in these groups was detected 1.70\% (2/117) and 0.48\% (1/205), respectively (\(P=0.3\)). In present study, nine related risk factors with toxoplasmosis were evaluated and data analysis showed that only contact with cat was significantly correlated with IgG seroprevalence (\(P=0.02\)).

Conclusions: Current research suggests thalassemia patients are more prone than normal persons to acquiring \textit{T. gondii} infection (\(P=0.04\), OR:1.77). Due to limited studies in this high risk group, further studies are recommended.

1. Introduction

Toxoplasmosis is a widespread zoonosis disease, caused by an obligate intracellular protozoan parasite known as \textit{Toxoplasma gondii} which can infect a wide range of warm-blooded vertebrates such as man, livestock, birds and marine mammals. For the first time it was characterized from liver and spleen smears in a north African rodent known as \textit{Ctenodactylus gondii} by Nicolle and Manceaux in 1908. Some routes of \textit{T. gondii} transmission include: food-borne (consuming raw meat, drinking water contaminated by oocyst, ingestion of undercooked meat contaminated by cyst, etc), zoonotic (ingesting oocysts shed by infected cats), congenital (mother to foetus), organ transplantation as well as blood transfusion\cite{1,2}. \textit{Toxoplasma} is mostly asymptomatic in immunocompetent individuals although it is considered as an opportunistic infectious agent in high risk groups which include: pregnant women, immunocompromised individuals, i.e. cancer patients, HIV+ and organ transplant recipients\cite{3-8}. It is estimated at least one third of the world’s population are infected\cite{1,9}. According to recent studies, it has been reported that seroprevalence of \textit{T. gondii} in Iranian general population...
population, Iranian pregnant women and, immunocompromised patients is 39%, 41% and, 50%, respectively [3,5,10]. Based on recent studies, chronic toxoplasmosis may associated with autoimmune and neurodegenerative disorders [11-15].

Thalassemia is one of the most common genetic disorders which happens due to mutation in genes responsible for creation of $\alpha$ or $\beta$ globulin chains and leads to non-production or reduced production of globin chains [16]. Due to severe anemia in thalassemia patients, numerous complications occur including: changes in the face, long bones, pathological fractures in spinal column, osteopenia, osteoporosis, short stature, hemolytic anemia, hepatomegaly, hepatocellular carcinoma, splenomegaly, heart failure, zinc deficiency, liver dysfunction, metabolic disorders, endocrine disorders, hypogonadism, spermatogenous cell abnormalities, etc [16, 17].

The national program for thalassemia control was initiated in 1996 in Iran and due to special attention to the disease, the number of afflicted newborns has declined. It is estimated 2-3 million carriers of thalassemia and 14,000 thalassemia patients exist in Iran [16, 18]. Over 25% of total national blood products have been used for thalassemia patients in Iran. Since pre-transfusion screening for T. gondii is not performed on blood packs, these patients are susceptible to acquiring toxoplasmosis; thus, the aim of this study was to evaluate the seroprevalence status of T. gondii in individuals who suffer from thalassemia in comparison to healthy persons in the southwest of Iran.

2. Materials and Methods

2.1. Study area

Ahvaz city, capital of Khuzestan province which is located in the southwest of Iran (31°50’ N and 49°11’ E), is ranked as the 7th largest city throughout the country and based on the latest census, its population is calculated about 1,395,184 in 352,128 families. Weather temperature is highly variable throughout the year so that in summer temperature exceeds 50°C whereas in winter it falls to 5°C. Also, annual average rainfall is approximately 230 mm [19, 20].

2.2. Study population

In this case-control study, blood samples were collected from 117 thalassemia patients as case group who referred to the Research Center of Thalassaemia and Haemoglobinopathies (RCTH) located at Shafa hospital affiliated to Ahvaz Jundishapur University of Medical Sciences, Iran (the only center working on oncology and hematology in the southwest region of Iran, Khuzestan province) for routine follow-ups by an oncology specialist. Each thalassemia patient had his/her own folder which included: epidemiological data, laboratory findings, prescribed drugs and the follow-up information. In addition, 205 serum samples were collected from non-thalassemia and apparently healthy persons as control group who were admitted to Golestan hospital, an educational hospital affiliated to Ahvaz Jundishapur University of Medical Sciences, Iran and adjacent to Shafa hospital. Inclusion criteria in our study were as follow: 1) individuals who agreed to participate in the study in both groups (after obtaining a written informed consent); 2) in case group: possessing personal folder as thalassemia patient in Shafa hospital; examination by physician to rule out malignancy or immunodeficiency disorders according to records documented in thalassemia patients folders and using routine laboratory findings; 3) in control group: complete blood count (CBC) to rule out thalassemia and anemia; lack of history of prior blood transfusions, checkup by physician to rule out any serious disease or immunodeficiency disorders.

2.3. Serology method

In order to detect specific IgG and IgM antibodies against T. gondii, 5 milliliters of venous blood was taken from each subject who met the above mentioned inclusion criteria of the study. Sera were separated by centrifugation at 4000 rpm for 5 minutes and then stored at -20°C until tested using enzyme-linked immunosorbent assay (ELISA) technique according to the manufacturer’s guideline as described earlier [6]. Anti-T. gondii IgG and IgM antibodies were measured using commercial ELISA kit (IgG and IgM, Trinity Biotech Captia™, Jamestown, NY, USA). For both IgG and IgM antibodies, the levels lower than 1.1 IU/mL were considered as negative samples and levels equal to or higher than 1.1 IU/mL were considered as positive samples.

2.4. Questionnaire

A questionnaire was filled out for each participant in both case and control groups containing the demographic information including: age (25 or less, 26-30 and >30), gender (Male or Female), residence (Urban or Rural regions), marital status (Single, Married, Divorced or Widowed), education level (Graduate school, 12years/High school or University degree), ethnicity (Fars, Arab, Lor, Key, Turk or Other), contact with cat (Yes or No), consumption of raw/undercooked meat (Yes or No), exposure to soil (Yes or No) and access to safe drinking water and sanitation.
2.5. Statistical Analysis

Data were analyzed using Chi-square test. The probability level of 0.05 was accepted as statistically significant. Statistical analyses were carried using SPSS version 16.

3. Results

3.1. Participants

In this study, a total of 322 subjects met the inclusion criteria and participated (117 thalassemia patients and 205 apparently healthy individuals). The mean age of participants in case and control groups was 26.01±9.69 and 28.42±10.26 years old, respectively.

3.2. Seroprevalence of anti-T. gondii antibodies

The seroprevalence of toxoplasmosis amongst thalassemia patients in terms of IgG and IgM was detected 30.76% (36/117) and 1.70% (2/117), respectively; while frequency of these antibodies in control group was 20% (41/205) and 0.48% (1/205), respectively. IgG seroprevalence between two groups was statistically significant \( (P=0.04) \), however no significant difference was observed in terms of IgM frequency between thalassemia patients and healthy persons \( (P=0.3) \) (Table 1).

| Table 1 |
| Analysis of anti-T. gondii IgG and IgM antibodies in thalassemia patients and control group |
| | Patients’ group n (%) | Healthy individuals n (%) | Sig. | OR. |
| IgG- positive | 36/117 (30.76%) | 41/205 (20%) | 0.04 | 1.77 |
| IgM-positive | 2/117 (1.70%) | 1/205 (0.48%) | 0.3 | 3.55 |

Abbreviations: Sig, Significance; OR, odds ratio.

3.3. Risk factors

In current survey, nine risk factors related to toxoplasmosis infection have been recorded. Univariate analysis of demographic

Table 2

Demographic characteristics and risk factors related to seroprevalence of T. gondii

| Characteristic | Thalassemia patients (N=117) | Controls (N=205) | Total (N=322) |
|---------------|-----------------------------|-----------------|---------------|
| Number IgG positive | P value | Number IgG positive | P value | Number IgG positive | P value |
| Gender | | | | | | |
| Male | 59 | 19 | 32.20 | 0.5 | 99 | 21 | 21.21 | 0.4 | 158 | 40 | 25.31 | 0.4 |
| Female | 58 | 17 | 29.31 | 106 | 20 | 18.86 | | 164 | 37 | 22.56 | |
| Age group (years) | | | | | | | | | | | |
| 25 or less | 51 | 16 | 31.37 | 0.8 | 84 | 18 | 21.43 | 0.2 | 135 | 34 | 25.18 | 0.5 |
| 26-35 | 45 | 13 | 28.88 | 77 | 14 | 18.18 | | 122 | 27 | 22.13 | |
| >35 | 21 | 7 | 33.33 | 44 | 9 | 20.45 | | 65 | 16 | 24.61 | |
| Residence | | | | | | | | | | | |
| Urban | 83 | 26 | 31.32 | 0.3 | 166 | 33 | 19.87 | 0.5 | 249 | 59 | 23.69 | 0.8 |
| Rural | 34 | 10 | 29.41 | 39 | 8 | 20.51 | | 73 | 18 | 24.65 | |
| Education level | | | | | | | | | | | |
| Grade school | 90 | 30 | 33.33 | 0.1 | 18 | 3 | 16.66 | 0.3 | 108 | 33 | 30.55 | 0.3 |
| 12 years/High school | 27 | 6 | 22.22 | 20 | 3 | 15 | | 47 | 9 | 19.14 | |
| University degree | 0 | 0 | 0 | | | | | | | | |
| Ethnicity | | | | | | | | | | | |
| Fars | 37 | 12 | 32.43 | 0.7 | 71 | 15 | 21.12 | 0.1 | 108 | 27 | 25 | 0.2 |
| Arab | 35 | 12 | 34.28 | 56 | 10 | 17.85 | | 91 | 22 | 24.17 | |
| Lor | 37 | 10 | 27.02 | 44 | 8 | 18.18 | | 81 | 18 | 22.22 | |
| Kord | 5 | 1 | 20 | 11 | 3 | 27.27 | | 16 | 4 | 25 | |
| Turk | 2 | 1 | 50 | 10 | 2 | 20 | | 12 | 3 | 25 | |
| Other | 1 | 0 | 0 | 13 | 3 | 23.07 | | 14 | 3 | 21.42 | |
| Contact with cat | | | | | | | | | | | |
| Yes | 83 | 26 | 31.32 | 0.5 | 80 | 23 | 28.75 | 0.01* | 163 | 49 | 30.06 | 0.02* |
| No | 34 | 10 | 29.41 | 125 | 18 | 14.4 | | 159 | 28 | 17.61 | |
| Consumption of raw/undercooked meat | | | | | | | | | | | |
| Yes | 18 | 5 | 27.77 | 0.4 | 14 | 3 | 21.42 | 0.5 | 32 | 8 | 25 | 0.2 |
| No | 99 | 31 | 31.31 | 191 | 38 | 19.89 | | 290 | 69 | 23.79 | |
| Exposure to soil | | | | | | | | | | | |
| Yes | 47 | 17 | 36.17 | 0.07 | 127 | 25 | 19.68 | 0.2 | 174 | 42 | 24.13 | 0.4 |
| No | 70 | 19 | 27.14 | 78 | 16 | 20.51 | | 148 | 35 | 23.64 | |
| Source of drinking water | | | | | | | | | | | |
| Purified water | 89 | 28 | 31.46 | 0.5 | 200 | 41 | 20.5 | 0.4 | 289 | 69 | 23.87 | 0.3 |
| Unpurified water | 28 | 8 | 28.57 | 5 | 0 | 0 | | 33 | 8 | 24.24 | |

*Statistically significant
between chronic and acute phase of toxoplasmosis.

Based on gender, the frequency of anti-*T. gondii* IgG antibodies was identified as being higher in males than females in both groups but the difference was not significant (**P**=0.4). Other surveyed risk factors, which have been listed in Table 2, show no significant relationship with toxoplasmosis.

**4. Discussion**

The prevalence rate of toxoplasmosis in the southwest of Iran ranged from 21% to 47% in different groups[4-6,10,15]. Present survey is the first study to evaluate the seroprevalence of toxoplasmosis amongst thalassemic patients in the southwest region of the country. Seroprevalence of anti-*T. gondii* IgG was identified in 30.76% (36/117) of patients and 20% (41/205) of healthy individuals (**P**=0.04), as well as anti-*T. gondii* IgM in these groups which was detected 1.70% (2/117) and 0.48% (1/205), respectively (**P**=0.3).

Karakas et al. studied 36 thalassemia patients and 36 healthy individuals in Turkey and the seroprevalence rate of toxoplasmosis in terms of IgG and IgM was reported 19.4% and 5.5% (borderline) among case group, respectively; while IgG was 14% in control group and no significant statistical difference was observed between two groups (**P**=0.752)[21], which is lower than our results. The reason for this could be study population, sample size, methodology, cultural habit of the region, etc. In this research, ELISA technique has been employed. Several serological methods are routinely used in order to detect IgG and IgM antibodies against *T. gondii*. Among them, ELISA with high sensitivity and specificity, is able to discern between chronic and acute phase of toxoplasmosis[22].

Approximately 14,000 thalassemic patients have been identified and registered in Iran with the median age of 15 years old[18]. The disease exists throughout the country, but it is more common in the bordering parts of the Oman Sea and Persian Gulf (Hormozgan, Bushehr and Sistan & Baluchestan provinces), adjacent parts of Caspian Sea (Mazandaran, Gilan and Golestan provinces) as well as Fars, Kerman and Khuzestan provinces. In the aforementioned regions, nearly 10% of the total population are β-thalassemia carriers, while in other zones of the country, it is less common and ranges between 3-8%. Also, nearly 1000 thalassemia major individuals are born in Iran every year[16].

Multiple blood transfusion is vital for thalassemia major patients; hence, they are prone to acquiring the blood-borne pathogens [23]. According to World Health Organization (WHO) strategies, screening of blood packs must be done for some blood-borne pathogens including: hepatitis B virus surface antigen (HBsAg), hepatitis C virus (HCV), human immunodeficiency virus (HIV) and Treponema pallidum in all countries and for human T-cell lymphotropic viruses I/II (HTLV I/II), human cytomegalovirus (CMV), Chagas disease and Malaria in some countries and endemic regions[24]; while pre-transfusion screening for *T. gondii* has not yet been performed. Also, there are some reports that documented *T. gondii* could thrive in citrated blood at 5°C for more than 50 days and blood transfusion contributes in the transmission of parasites by blood products[25, 26]. Seroprevalence of toxoplasmosis in healthy blood donors range from 1-75% worldwide[9]. Also, in some studies conducted in different geographical areas of Iran, the prevalence rate of *T. gondii* amongst blood donors from southern, southeastern and northern regions was reported 19.3%, 25%, 56.4%, respectively, which indicates existence of this infectious agent in all major areas of the country[9].

It should be noted that nearly 25% of total national blood products is being used for thalassemia patients in Iran[18]. Numerous reports have documented the prevalence of transfusion-transmissible infections (TTI) in high risk groups, particularly different multi-transfused patients. For instance, seroprevalence of human T-cell leukemia virus Type-1 (HTLV-1) was tested in both thalassemia and hemodialysis patients in the southwest of Iran. The results showed a significant frequency among case group (7.6% - 27/357) in comparison with control group (0.62% - 5/800)[27] that is in agreement with current study. Furthermore, seroprevalence of hepatitis infection in high risk groups such as sickle cell anemia patients, persons with haemophilia, hemodialysis patients and patients with thalassemia is reported by several authors ranging between 1.1-5.1% for HBV and 7.9-54% for HCV in the southwest of Iran[28-31]. In another study, anti-*T. gondii* antibodies were examined in hemodialysis patients. Seroprevalence rate of IgG and IgM was observed in 29.3% and 7.9% of patients, respectively; while in control group seropositivity for these antibodies was 26% and 4%, respectively. The difference between two antibodies was statistically significant (**P**=0.05)[6].

In present research, 9 related risk factors with toxoplasmosis were evaluated and data analysis showed that only contact with cat was significantly correlated with IgG seroprevalence (**P**=0.02). Since felines are the definitive hosts for *T. gondii* and they are in close contact to humans particularly in rural regions, accordingly, there is a general agreement that contact with cat with maintaining...
the disease transmission chain, is considered as a potential risk factor in the majority of studies[5, 9, 10, 32, 33]. As it was mentioned in study area section, Khuzestan province due to its proximity to the sea, had appropriate humidity that is vital for oocysts sporulation. The oocysts are shed in large amount through feces of infected cats and can live for several months in moist soils[32]. Thus exposure to soil could have a key role in toxoplasmosis morbidity. However, in our results this risk factor was not significant in two groups (P=0.07 and P=0.2 in case and control group, respectively) that corresponds to Zemene et al’s study among pregnant women [34], while Cong et al. showed exposure to soil is associated with persistence of *T. gondii* in study population[35]. Consumption of raw/undercooked meat is one of the studied risk factors in our study that was not statistically significant (P=0.4 and P=0.5 in thalassemia patients and control individuals, respectively). In some studies it has been shown that consumption of raw meat is not correlated with toxoplasmosis[5,35-38] while results of other investigations are in contrast[9,10]. Risk factors like gender, residence, age group, educational level, ethnicity and source of drinking water which have been detailed in Table 2, were not statistically significant in current study.

There is evidence which suggests that, despite the constant presence of anti-*T. gondii* IgM antibodies in serum, no positive IgM-ELISA can be indisputably considered as an acute infection[6]; thus, PCR-based techniques to explore DNA of *Toxoplasma* is required in future studies.

5. Conclusion

Our study suggests thalassemia patients are more susceptible than control persons to acquiring toxoplasmosis (P=0.04); thus, due to rare studies in this high risk group, further studies are recommended.

Conflict of interest statement

The authors declare no conflict of interests.

Acknowledgments

We thank all staff of cellular and molecular research center of Ahvaz Jundishapur University of Medical Sciences. This study was financially supported by Student Research Committee of Ahvaz Jundishapur University of Medical Science, Iran (NO: 92S.1) and approved in the ethical committee.

References

[1] Robert-Gangneux F, Darde ML. Epidemiology of and diagnostic strategies for toxoplasmosis. *Clinical microbiology reviews*. 2012;25:264-96.

[2] Khademvatan S, Foroutan M, Hazzrati-Tappeh K, Dalvand S, Khalkhal H, Masoumifard S, et al. Toxoplasmosis in rodents: A systematic review and meta-analysis in Iran. *J Infect Public Health* 2017; doi: 10.1016/j.jiph.2017.01.021.

[3] Ahmadpour E, Daryani A, Sharir M, Sarvi S, Aarabi M, Mizani A, et al. Toxoplasmosis in immunocompromised patients in Iran: a systematic review and meta-analysis. *J Infect Dev Ctries*. 2014;8:1503-10.

[4] Saki J, Shafieienia S, Foroutan-Rad M. Seroprevalence of toxoplasmosis in diabetic pregnant women in southwestern of Iran. *Journal of Parasitic Diseases* 2016; 40: 1586-9.

[5] Foroutan-Rad M, Khademvatan S, Majidiani H, Aryamand S, Rahim F, Malehi AS. Seroprevalence of *Toxoplasma gondii* in the Iranian pregnant women: A systematic review and meta-analysis. *Acta tropica*. 2016;158:160-9.

[6] Saki J, Khademvatan S, Soltani S, Shabbazian H. Detection of toxoplasmosis in patients with end-stage renal disease by enzyme-linked immunosorbent assay and polymerase chain reaction methods. *Parasitology research*. 2013;112:163-8.

[7] Saki J, Mohammadpour N, Moramezi F, Khademvatan S. Seroprevalence of *Toxoplasma gondii* in women who have aborted in comparison with the women with normal delivery in Ahvaz, southwest of Iran. *ScientificWorldJournal*. 2015;2015:764369.

[8] Gharavi MJ, Jalali S, Khademvatan S, Heydari S. Detection of IgM and IgG anti-*Toxoplasma* antibodies in renal transplant recipients using ELFA, ELISA and ISAGA methods: comparison of pre- and post-transplantation status. *Annals of tropical medicine and parasitology*. 2011;105:367-71.

[9] Foroutan-Rad M, Majidiani H, Dalvand S, Daryani A, Kooti W, Saki J, et al. Toxoplasmosis in Blood Donors: A Systematic Review and Meta-Analysis. *Transfusion medicine reviews*. 2016;30:116-22.

[10] Daryani A, Sarvi S, Aarabi M, Mizani A, Ahmadpour E, Shokri A, et al. Seroprevalence of *Toxoplasma gondii* in the Iranian general population: a systematic review and meta-analysis. *Acta tropica*. 2014;137:185-94.

[11] Sutterland AL, Fond G, Kuin A, Koeter MW, Lutter R, van Gool T, et al. Beyond the association. *Toxoplasma gondii* in schizophrenia, bipolar disorder, and addiction: systematic review and meta-analysis. *Acta Psychiatr Scand*. 2015;132:161-79.

[12] Flegr J, Prandota J, Sovickova M, Israli ZH. Toxoplasmosis—a global
threat. Correlation of latent toxoplasmosis with specific disease burden in a set of 88 countries. PloS one. 2014;9:e90203.

[13] Majidiani H, Dalvand S, Daryani A, Galvan-Ramirez ML, Foroutan-Rad M. Is chronic toxoplasmosis a risk factor for diabetes mellitus? A systematic review and meta-analysis of case-control studies. The Brazilian Journal of Infectious Diseases 2016;20:605-9.

[14] Khademvatan S, Saki J, Khajeddin N, Izadi-Mazidi M, Beladi R, Shafiee B, et al. Toxoplasma gondii Exposure and the Risk of Schizophrenia. Jundishapur J Microbiol. 2014;7:e12776.

[15] Khademvatan S, Khajeddin N, Saki J, Izadi-Mazidi S. Effect of toxoplasmosis on personality profiles of Iranian men and women. S Afr J Sci. 2013;109:92-5.

[16] Moradi G, Ghaderi E. Chronic disease program in Iran: Thalassemia control program. Chron Dis J. 2013;1:98-106.

[17] Borgna-Pignotti C, Cappellini MD, De Stefano P, Del Vecchio GC, Forni GL, Gamberrini MR, et al. Survival and complications in thalassemia. Ann NY Acad Sci. 2005;1054:40-7.

[18] Abolghasemi H, Amid A, Zeinali S, Radfar MH, Esghii P, Rahiminejad MS, et al. Thalassemia in Iran: epidemiology, prevention, and management. J Pediatr Hematol Oncol. 2007;29:233-8.

[19] Saki J, Foroutan-Rad M, Asadpouri R. Molecular Characterization of Cryptosporidium spp. in Wild Rodents of Southwestern Iran Using 18s rRNA Gene Nested-PCR-RFLP and Sequencing Techniques. J Trop Med. 2016;2016:6834206.

[20] Khademvatan S, Masjiedzadeh R, Rahim F, Mahbodfar H, Salehi R, Yousefi-Razin E, et al. Blastocystis and irritable bowel syndrome: Frequency and subtypes from Iranian patients. Parasitology international. 2017;66:142-5.

[21] Karakas S, Ozlem S, Tellioglu AM, Ertabaklar H, Ertug S. [Investigation of anti-Toxoplasma gondii IgG and IgM antibodies in beta-thalassemia major patients in Aydin province]. Turkiye parazitoloji dergisi. 2012;36:133-6.

[22] Gharavi MJ, Oormazdi H, Rooointan ES. A Comparative Study on Sensitivity and Specificity of Conventional and Unconventional IgG and IgM Assays for Diagnosis of Toxoplasmosis. Iran J Public Health. 2008;37:42-5.

[23] Prati D. Benefits and complications of regular blood transfusion in patients with beta-thalassemia major. Vox Sang. 2000;79:129-37.

[24] WHO. Screening donated blood for transfusion-transmissible infections: recommendations: World Health Organization; 2010.

[25] Nelson JC, Kauffmann DJ, Ciavarella D, Senisi WJ. Acquired toxoplasmic retinochoroiditis after platelet transfusions. Ann Ophthalmol. 1989;21:253-4.

[26] Siegel SE, Lunde MN, Gelderman AH, Halterman RH, Brown JA, Levine AS, et al. Transmission of toxoplasmosis by leukocyte transfusion. Blood. 1971;37:388-94.

[27] Karimi A, Nafici M, Imani R. Comparison of human T-cell leukemia virus type-1 (HTLV-1) seroprevalence in high risk patients (thalassemia and hemodialysis) and healthy individuals from Charmahal-Bakhtiari province, Iran. Kowsar M J. 2007;9:259-61.

[28] Ghafourian-Boroujerdina M, Assarehzadegan MA, Zandian K. Hepatitis B and C Infections and Different Genotypes of HCV Among Sickle Cell Anemia Patients in Ahvaz, South-Western Iran. Jundishapur J Microbiol. 2013;6.

[29] Assarehzadegan MA, Ghafourian Boroujerdina M, Zandian K. Prevalence of hepatitis B and C infections and HCV genotypes among haemophilia patients in ahvaz, southwest iran. Iran Red Crescent Med J. 2012;14:470-4.

[30] Boroujerdina MG, Zadeganl MAA, Zandian KM, Rodan MH. Prevalence of Hepatitis-C Virus (Hcv) among Thalassemia Patients in Khuzestan Province, Southwest Iran. Pak J Med Sci. 2009;25:113-7.

[31] Assarehzadegan MA, Shaherinejad G, Noroozkhonejad R, Amini A, Rahim Rezaee SA. Prevalence of hepatitis C and B infection and HC V genotypes among hemodialysis patients in Khuzestan province, southwest Iran. Saudi J Kidney Dis Transpl. 2009;20:681-4.

[32] Rahimi MT, Daryani A, Sarvi S, Shokri A, Ahmadpour E, Teshnizi SH, et al. Cats and Toxoplasma gondii: A systematic review and meta-analysis in Iran. Understpoopoet J Vet Res. 2015;82:823.

[33] Dubey JP, Lago EG, Gennari SM, Su C, Jones JL. Toxoplasmosis in humans and animals in Brazil: high prevalence, high burden of disease, and epidemiology. Parasitology. 2012;139:375-424.

[34] Zemene E, Yewhalaw D, Abera S, Delay T, Samuel A, Zeynudin A. Seroprevalence of Toxoplasma gondii and associated risk factors among pregnant women in Jimma town, Southwestern Ethiopia. BMC Infect Dis. 2012;12:337.

[35] Cong W, Dong XY, Meng QF, Zhou N, Wang XY, Huang SY, et al. Toxoplasma gondii Infection in Pregnant Women: A Seroprevalence and Case-Control Study in Eastern China. Biomed Res Int. 2015;2015:170278.

[36] Alvarado-Esquivel C, Sifuentes-Alvarez A, Narro-Duarte SG, Estrada-Martinez S, Diaz-Garcia JH, Liesenfeld O, et al. Seroepidemiology of Toxoplasma gondii infection in pregnant women in a public hospital in northern Mexico. BMC Infect Dis. 2006;6:113.

[37] Andiappan H, Nissapatorn V, Sawangjaroen N, Chemoh W, Lau YL, Kumar T, et al. Toxoplasma infection in pregnant women: a current status in Songklanagarind hospital, southern Thailand. Parasit Vectors. 2014;7:239.

[38] Nissapatorn V, Kamanulzaman A, Init I, Tan L, Rohela M, Norliza A, et al. Seroepidemiology of toxoplasmosis among HIV-infected patients and healthy blood donors. Med J Malaysia. 2002;57:304-10.