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"Evaluation of iron status in voluntary blood donors"

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In the name of God
the compassionate,
the merciful

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DEDICATION

This thesis is dedicated to:

My wife Elaheh for her endless love, support and encouragement

My loving children Tahereh and Bahareh

My beloved brothers and sisters

My parents, although gone now but never forgotten. I will miss them always and love them forever

ABSTRACT

Introduction:

Blood is a vital fluid for human life. Essential needs of all cells and organs of the body are provided by blood. Human with all the scientific and technological progresses have been so far failed to find a proper alternative for blood. In fact, blood donation is called "life donation".

However, blood donors are more susceptible to iron deficiency, since in each blood donation they will lose between 200 to 250 mg of their iron stores.

Aim of study:

Iron deficiency is one of the well-known risk factors of blood donation attempts deferral worldwide. Hence, aim of this study is to evaluate iron status of blood donors with more laboratory examinations. This is investigated to see if iron deficiency can be one of the possible reasons for the decrease in statistics of blood donation in the University Hospital Dusseldorf.

Materials and methods:

During this study, randomly 280 volunteer's data inclusive 30 first-time donors and 250 frequent donors (more than one donation) with equal male to female ratio and average age of 34.9 years have been analyzed after receiving statement of University Ethic Commission.

For all donors, complete blood count (CBC) test and special iron tests including serum iron, serum ferritin, transferrin and transferrin receptors have been done and relevant information was extracted. Evaluation of the data was conducted using with the statistical software SPSS (version 20) and R (version 3.0.1).

Results:

The relationship between serum ferritin level and the number of donations was statistically significant (P 0.000)**.** Overall 21.77% (61 of 280) of all donors had iron store deficiency (serum ferritin < 15µg/l) including 60 frequent donors and only one first time

donor. 26% of all donors with more than 5 donations had a latent iron deficiency. A significant relationship was observed between ferritin level and donor's gender ($P<0.05$). Iron store depletion among the female donors occurs about two times more common than among the males (28.57% (40) vs. 15% (21).

Conclusion:

According to the results obtained, as the blood donation count increases, serum ferritin level decreases. It is based on international experiences and confirms previous studies on the impact of blood donation on depletion of the body iron storage. Iron store deficiency can also be one of the reasons for the decrease in the number of blood donation in the University Hospital Dusseldorf. That is why donors who are at this stage and do not receive iron supplements, can get close to the iron deficiency anemia in the near future. Indeed, their hemoglobin level can be lower than the standard value for blood donation. Hence, they would not be able to donate blood anymore. The results also indicate the need to regulatory monitoring the iron status of voluntary blood donors.

Keywords: Blood donation; Iron deficiency; Iron stores; Ferritin; Hemoglobin; Dusseldorf

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CHAPTER 1
INTRODUCTION

1.1. Statement of purpose

Blood is a fluid connective tissue that flows in the vessels of all human beings. With its circulation in the body, it brings passion, vita and life to cells and tissues. The pulse of the life beats in the vessels, which blood flowing through them. This red vital liquid forms about 7% of human body weight [1]. In other words, blood volume for an average 70 kg adult human is about 5 liters [2].

Blood is composed of two components of liquid and cellular. The liquid part of blood is called plasma. Plasma is make up about 60% of the blood volume where the blood cells floating in it. This liquid is composed of mostly water and small amount of protein, electrolytes and the rare elements, which are needed for the body. The main role of this vital fluid is to provide nutrients needed for cells and disposal of the waste products of various cells and tissues. In addition, coagulation factors required for blood clotting and the carrier protein of hormones are floating in this part of blood [3].

The cellular part of blood forms the rest of blood volume. It is composed of red cells, white cells and platelets that are responsible for distribute oxygen to the cells and tissues, defending against infectious agents and foreign substances and participation in primary blood coagulation, respectively [4].

The hematopoietic system in the body is normally responsible for producing the blood cells on time and correctly. However, some people require blood replacement due to inadequate or ineffective blood production or excessive blood loss. The most frequent indications of blood transfusion are in the patients with trauma, surgery, obstetric procedures, cancer, chronic diseases of the bone marrow, etc.

Human with all the scientific and technological progresses have been so far failed to find a proper alternative for blood. Therefore, there is no other option for patients to receive blood from anywhere else rather than from other people. Hence, blood donation is called "life donation ".

Nowadays, the importance of blood donation is obvious for everybody. If in the past, the donated blood rescued only one person, today, with the improvement of technology and the separation of blood components and optimizing the usage, a safe

blood donation contains approximately 500 ml of whole blood can help more than three patients. On the other hand, now with the method called apheresis each component of blood like erythrocyte, leukocyte, platelet or blood plasma can be donated individually. These donated blood products are determined for patients who need these components.

There must be for sure a healthy donor for a healthy donation. Blood donation eligibility criteria are determined based on international and regional standards. Every country has its own guide. One of the general and common conditions of a safe donation in the world is that donors should have sufficient amount of iron in their bodies. The importance of the subject is that donor would not be at the risk of iron deficiency and the donated blood contains enough iron loads for the patient.

1.2. Importance of the subject and aim of study

Maintenance of the blood donation chain requires monitoring and constant care of donors. People whom are considered as non-renewable resources of blood donation and the heart of patients beats with them donations.

Monitoring the iron status should be considered with the aspects of continuous maintaining of the blood donors and ensuring their health. Since, the only disadvantage known as blood donation is the potential risk of iron deficiency. Currently, iron deficiency is one of the temporary limiting factors of blood donation in the world. If the blood donation will be continued without compensation of the wasted iron, it can cause iron depletion, iron store deficiency and in advanced stages iron deficiency anemia. This can be presented as low-level hemoglobin in the blood donation screening. Consequently, volunteers would not be allowed to donate. This is one of the main causes of temporary blood donation deferral, particularly in women.

In Germany, the blood donation process is set based on the book "*Richtlinien zur Gewinnung von Blut und Blutbestandteilen und zur Anwendung von Blutprodukten (Hämotherapie)*" [5]. According to this guideline, minimum hemoglobin of 12.5 g/dl in females and 13.5 g/dl in males is the main criteria for screening blood donors. The hemoglobin level is determined using a spectrophotometer in capillary blood from

finger prick. If hemoglobin levels are lower than the cut-off levels in two measurements, donors will not be permitted to donate any blood product.

The blood donation center of the University Hospital Dusseldorf is the main supplier of blood products for inpatients, outpatients and surgical and trauma of the hospital. In this center, donating the whole blood and platelet with apheresis method is possible. Each year, about 12,000 whole blood units and 10,000 platelet units are donated in this hospital.

Unfortunately, in recent years, statistics of whole blood donation in the hospital especially for frequent blood donors decreased and no studies have been conducted to understand the reasons for this reduction. This problem causes concern about the supply of blood and blood products for patients. Hence, the hospitals have been forced to order more blood from external producers.

According to the guideline for blood donation in Germany, several different factors can temporarily or permanently prevent blood donation. Iron deficiency is one of the known temporary factors to blood donation attempt deferral in the world and clearly can decrease blood donation statistics. Therefore, in this study it has been decided to evaluate the iron status in one group of blood donors in this hospital. Unfortunately, no information about the iron status of donors, particularly, frequent donors are available.

The aim of this study is to evaluate iron status, particularly body iron stores with more laboratory examinations. It is concerned to know if iron deficiency can be one of the possible reasons for the decrease in statistics of blood donation in the University Hospital Dusseldorf.

CHAPTER 2
LITERATURE REVIEW

2.1. The importance of iron

Iron is one of the required essential trace elements for all organisms, especially, human beings [6]. This element plays an important role for human health and cells function in the body. The most important role of iron is the help to produce hemoglobin, which carries oxygen from lungs to the cells [6, 7]. Besides, by taking part in immune system, it helps the body to protect from foreign invasive pathogens [8]. In addition, it exists in many energy producer enzymes, such as catalases, peroxidases and cytochrome enzymes [9, 10, 11]. Being one of the most abundant metals in the human body, iron plays important roles in cellular process such as the synthesis of DNA, RNA, and proteins, electron transport, cellular respiration, cell proliferation and differentiation; and regulation of gene expression [12, 13,14]. Indeed, nervous system needs iron for its development and to myelin formation [15, 16, 17, 18, 19]. Therefore, body cells require ongoing iron-rich foods to maintain their vital functions [7].

2.2. Iron in body

The amount of iron in body is written differently in various references. Sometimes this amount is mention as a general value, for instance, from 3000 to 4000 mg for men and from 2000 to 3000 mg for women [20]. In some references, it is calculated based on the body weight, like: 35 and 45 mg/kg for women and men, respectively [21, 22, 23].

Because of the major role of iron in hemoglobin structure, the most amount of the total body iron (between 60 to 70%) for building hemoglobin is used in a process called erythropoiesis. For a healthy person, between 20 to 30 % of the surplus iron (0 to 2 g) is stored as iron in the form of ferritin and hemosiderin in liver and reticuloendothelial macrophages [10]. In addition, up to 10% of iron can be founded in other iron containing enzymes like myoglobin and cytochrome. Less than 1% of iron (about 4mg) which is bound to transferrin, floating in plasma. Although, this amount is small but the daily turnover of the attached iron to transferrin is about 25 mg [10]. 80% of the iron that is transferred daily with transferrin, is used to synthesis of new red cells in bone marrow (20 mg per day)[24, 25].

2.3. Iron requirements and its sources

As a general principle, it can be said that the daily iron requirements amount for women and healthy adult men is between 1 to 2 mg [6, 26]. This amount should be absorbed from food in the gastrointestinal tract. However, the need for iron for individuals and specific groups like growing children, pregnant and lactating women and blood donors is calculated based on the elements like age, gender and environmental conditions and it could exceed this calculated amount [27, 26].

The major requirement of iron for body is consumed to make new red blood cells, which live for about 120 days. On average, about 20 mg iron per day is needed to produce hemoglobin in red blood cells. More often, this is achieved from destruction of old red blood cells in reticuloendothelial macrophages and its recycle in plasma [6, 7, 28, 29].

On the other hand, from 1- 2 mg iron is excreted from body through physiological fluids, intestinal tract and skin every day [12, 22, 28]. Exactly, the same amount of iron is absorbed through intestinal tract and foods to compensate the lost one.

Iron can be founded in two forms of organic (heme iron) and nonorganic (non-heme iron) in food. The details are given in the below table:

Iron	heme	non-heme
Sources	As hemoglobin and myoglobin in meat and animal tissues including red meat, poultry, fish and liver [30, 31]	Wide variety of iron-containing plant foods such as whole grains, legumes, vegetables, nuts and types of dried fruits[32, 33]
Absorption	Effectively absorbed [34, 35, 36, 37] (20-30%)	Absorbed ineffectively [32, 33] (3- 8%)

Table 2.1.Iron forms

Meat, poultry and fish increase iron uptake. These foods are worth double. They contain “heme iron” and in the other hand, they increase the absorption of “non-heme iron” found

in plant sources. One of the most important measures to prevent iron deficiency anemia is educating nutritional tips in order to make balance and variety in the diet.

2.4. The mechanism of intestinal iron absorption

The absorption of iron from food in body is mainly done in three steps by the specialized enterocytes cells at the proximal of small intestine [38, 39] (fig. 2.1). These steps are:

- ***Absorption of iron from apical membrane of enterocytes:***

Iron should be in the reduced form (ferrous- Fe2+) to cross this membrane. In this step, organic iron (heme) which is in the form of ferrous can pass the membrane without any transforming with the help of heme transporter and enter the intestine cytosols [40].

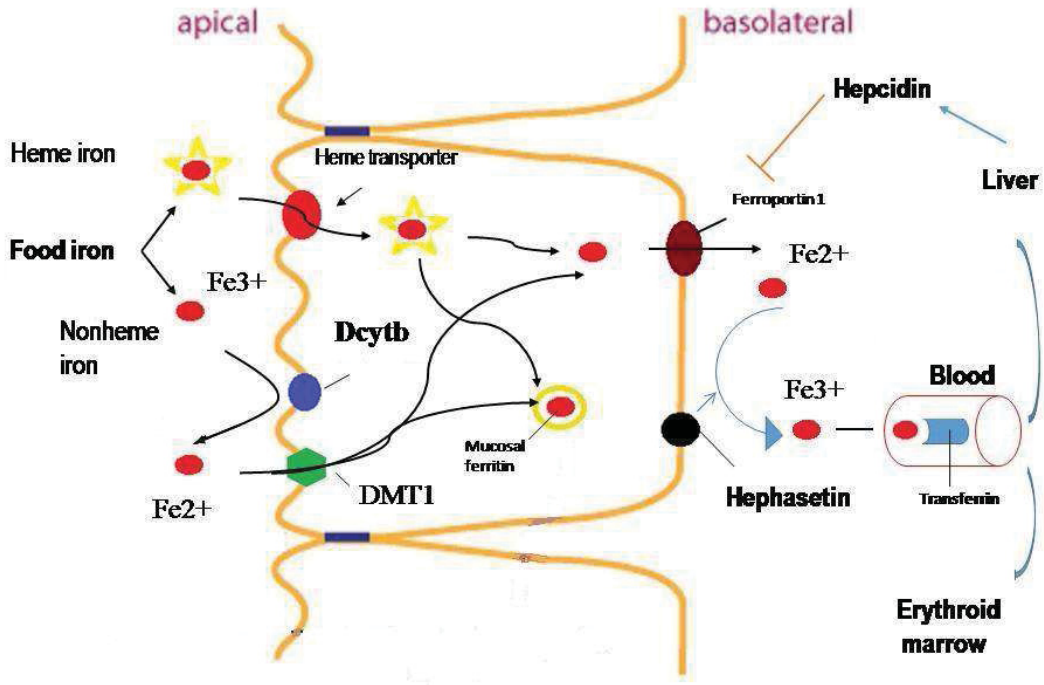

Fig.2.1.Intestinal iron absorption

(Toolabi, A. unpublished image 2016)

The nonorganic (non-heme) iron is generally found in the form of ferric iron (Fe+3). It should be first converted to ferrous iron for crossing through the intestinal membrane. If it is not done in the acidic environment of the stomach, then it should be reduced by enzyme called duodenal cytochrome B (Dcytb)/ferrireductase which is place at apical intestinal villi and exchanged to ferrous [30, 32, 41, 42, 43]. After that, a protein called Divalent Metal Transporter 1 (DMT1) facilitates the passage of ferrous iron from intestine membrane to entrocyts [6, 32, 43, 44].

From here onwards, the mechanism of iron absorption is the same for both organic and nonorganic forms.

- ***Iron departure from intestinal cells and entrance to the bloodstream:***

Without an emergency being present, the ferrous iron obtained (from first step) can be stored as mucosal ferritin in entrocyts [32, 43, 45]. Otherwise, it can be directly transferred to plasma with the help of protein called ferroportin 1 also known as iron-regulated transporter [32, 43, 44, 45]. This step is one of the iron regulatory mechanisms in the body. The activity of ferroportin can be inhibited by an enzyme inhibitor called hepcidin. From this way, it can cause the reduction of the iron entry to the blood stream. Hepcidin is a peptide hormone that synthesized in liver [46]. Many people believe that this hormone is the key regulator of iron in the blood of humans and other mammals [7].

- ***Iron exportation:***

In this step, a rework is done. The ferrous iron will be again oxide and exchange to ferric iron to be able to bind to transferrin to carry the bloodstream. This exchange is done with another enzyme called hephasetin (ferroxidase) [32, 43, 44. 45].

2.5. Iron transport and storage

These functions are done by three major proteins named transferrin, transferrin receptor and ferritin [34].

2.5.1. Transferrin

Transferrin is a glycoprotein with 80 kDa molecular weight that mainly synthesized in

the liver [47] but a small amount is produced in other organs such as brain and testis [48, 49]. This protein is responsible to bound to iron and transfers iron to the different cells and tissues [6, 50, 51].

Transferrin has a high tendency to bind to ferric iron from the intestine [6]. In addition, it is responsible for transportation of iron obtained from the destruction of the old red blood cells in the reticuloendothelial system [44]. Normally, in healthy people, only 30% of the transferrin iron binding capacity is filled and the remaining 70% is used when a large amount of iron is needed [49]. Otherwise, in case of iron overload, the excessive part of it is bound to transferrin, to prevent it from destructive toxic effects on body [52].

In the case, where all the capacity of transporting iron by transferrin is saturated, a small amount of iron can be attached to the albumin and other small molecules in the blood. These proteins are so-called Non-transferrin bound iron (NTBI) [7].

2.5.2. Transferrin receptors

These are the key receptors on the cells surface that cause the harvesting of attached iron to transferrin. There are two types of transferrin receptor in body and each of them is belonged to specific cells and tissues. One type exists in all cells except mature erythrocytes while the other type only exists in liver hepatocytes [6].

The amount of iron, which is needed for cells and tissues, depends on the appearance of ternsferin receptors on the surface of these cells and tissues [26]. Despite the fact that the erythropoiesis happens in the bone marrow and the major amount of body iron is used for producing hemoglobin, about 80% of transferrin receptors can be found in hematopoietic cells in bone marrow [26, 53]. In the case when the demand for iron increases, especially, in case of iron deficiency, the amounts of these soluble receptors increase [54, 55, 56, 57]. The important note is that, these receptors are not affected by the infection and do not belong to the Acute-phase reaction proteins [58, 59, 60].

2.5.3. Ferritin

Excessive iron over used of the capacity of bone marrow hematopoietic will be stored in the form of ferritin in the liver, the bone marrow and reticuloendothelial system [6].

Ferritin is an intracellular iron storage protein with molecular weight of 465 KDa [37] (fig.2.2).

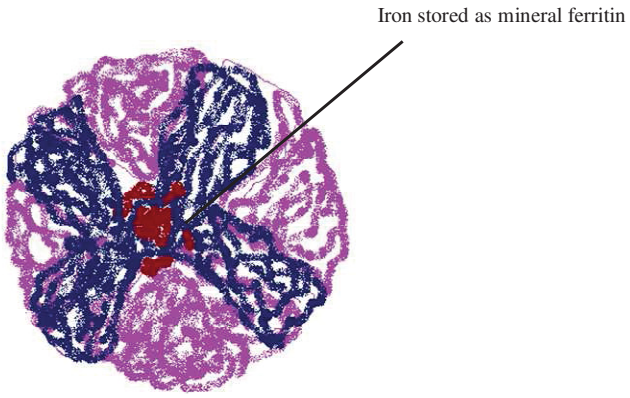

Fig.2.2. Ferritin structure
(Modified image of R. Vidal, Indiana University, Bloomington, USA) [97]

Approximately, it can be produced in all body cells [61]. The part of ferritin that is not attached to iron is called apoferritin [44]. Ferritin is one of the acute-phase reaction proteins and its measurements could be inaccurately up and down in patients [62, 63].

If the total amount of the body iron exceed more than the binding capacity of apoferritin, then the excessive iron can be stored in an insoluble structure named hemosiderin [64]. In this case, the intestinal absorption of iron is sharply reduced. On the other hand, when iron stores are empty, the intestinal absorption capacity can be increased up to 5 times of the normal rate. Therefore, the regulatory mechanism of the intestinal iron absorption is one of the main and useful ways to adjust iron in the body [44].

2.6. Iron disorders

Although, iron is one of the important elements for body, but the iron uptake, transport and storage should be controlled constantly to prevent harmful effects of excess iron [65, 66, 67]. Since, in a physiological state, the amount of iron excretion is limited, therefore, control mechanisms are more focused on the absorption of iron in the gastrointestinal tract.

2.6.1. Iron overload and its complications

In contrast to iron deficiency, iron overload is a rare situation where it could be dangerous if it would not be diagnosed, on time or misdiagnosed [26]. It happens when taking iron would be more than the need and the saturation value in body. In this case, the iron storing proteins level like ferritin and hemosiderin will increase. This overloaded iron would cause harm effects on parenchymal tissues due to the toxic effects resulting from superoxide and hydroxyl radicals [6, 64]. The toxic radicals can destroy the nuclei of cells and stop the production of the proteins needed for cell development. Also, they could lead to cell death, if they not be treated [6]. Accordingly, early diagnosis of this disease can prevent from occurrence of the destructive consequences.

In general, the accumulation of the excessive iron in body is called "Hemochromatosis". This exists in two the forms of primary (hereditary) and secondary (acquired) [26]. The primary hemochromatosis with the above-mentioned mechanism can cause several diseases such as cirrhosis, cardiovascular diseases, arthritis, diabetes, hypogonadism, skinrash and etc. [68].

Nowadays, the relationship between genes (HEF) responsible for creating primary hemochromatosis and major histocompatibility complex (MHC1) is known and it can be helpful for screening family members of patients[69, 70].

The secondary (acquired) hemochromatosis or hemosiderosis is more related to hematopoietic disorders or ineffective hematopoiesis in the body such as in thalassemic, aplastic and sideroblastic anemias. The other reasons of this type of disease could be due to the frequent blood transfusions or frequent iron injection, high iron-rich foods and chronic diseases affecting the body’s hematopoietic system [26].

2.6.2. Iron deficiency and its complications

Iron deficiency is one of the most important problems in the world today, especially in developing countries. Almost one third of the world's population suffers from iron deficiency [7, 44]. Inadequate dietary iron intake, increased iron requirements during pregnancy, lactation, menstruation, growing and adolescents, etc. are physiologic causes of iron deficiency [26]. In contrast, chronic gastrointestinal and uterine bleeding are the most important pathologic causes of iron deficiency in developed countries [37, 44]. Other pathological related conditions are intestinal iron absorption disorders, malignant tumors, and chronic inflammatory bowel diseases [26].

Frequent blood donation is another reason for appearance of iron deficiency. Unlike the previous factors, it can cause iron stores depletion in a shorter time, if the iron lost during the blood donation process is not compensated at the right time [26].

Since, each blood donation reduces between 200 to 250 mg of iron stores; therefore, blood donation has the greatest impact on reducing serum ferritin level more than other iron parameters. That is why so many people denote the blood donation as "iron donation". The potential risk of iron deficiency is the only disadvantage of blood donation, which is known so far [26].

The iron deficiency that is not compensated overtime could eventually lead to iron deficiency anemia with clinical complications. Three stages of iron deficiency leading to iron deficiency anemia are listed in Table 2.2.

2.7. The laboratory investigation of iron deficiency

Currently, there is no laboratory test, which lonely could indicate iron deficiency [55, 62]. Only by combining a series of biochemical iron tests, in which, each consider the body iron from different aspects, the balance of body iron, especially iron deficiency can be checked [54,55,71,72,73,74,75]. According to World Health Organization (WHO) recommendation, the best combination in a population-based research setting would be hemoglobin, serum transferrin receptors, and serum ferritin or bone marrow iron [55].

Prelatent (Mildest form or pre-hidden iron deficiency)	Iron stores depletion in the liver and bone marrow without clinical symptoms and affecting on erythropoiesis , alarming sign of iron deficiency [6, 26, 54]
Latent (Hidden iron deficiency)	Continued iron deficiency and iron stores depletion, negative iron balance (decrease absorption, increase consumption), decrease of functional iron and reduction of transport, low serum iron, iron-deficient erythropoiesis, without clinical symptoms [6, 26, 54]
Apparent	Most severe form of iron deficiency, continuation of the iron deficiency and further depletion of iron stores, a significant reduction of functional iron and transport iron, no iron to produce hemoglobin, decreased hemoglobin levels, producing small pale red blood cells (microcyt, hypochrom), clinical symptoms of iron deficiency anemia [26, 54]

Table 2.2. Three stages of iron deficiency

In this regard, two groups of experiments can be studied:

2.7.1. The complete blood count (CBC) test:

It is determine to evaluate of iron deficiency effects on hemoglobin synthesis and red blood cell parameters in erythropoiesis. Progressive and severe iron deficiency at the last stages can lead to disorders in producing red blood cells and cause the iron deficiency anemia (IDA) [54, 55,]. This effect can be observed in the CBC test, resulting to reduce hemoglobin and hematocrit levels [76], and decrease in red blood cell parameters, which include Mean corpuscular volume (MCV) and Mean corpuscular hemoglobin (MCH) [54].

A measurement of hemoglobin level is one of the tests recommended by the WHO for screening the iron deficiency [55]. According to the organization's definition, anemia is determined in adult women and men with the hemoglobin of less than 12 and 13g/dl respectively [55].

Since, the first stage of iron deficiency does not interfere the process of erythropoiesis, and the CBC test could look normal, thence, doing some specific biochemical iron indices tests for measuring the iron body is necessary.

2.7.2. Assesment of iron status by measuring the iron indices: (Serum ferritin, serum iron, transferrin, and transferrin receptors).

Ferritin is an intercellular protein but a small part of it is free in plasma and measurable with the so-called serum ferritin [64, 77]. Serum ferritin level is closely correlate with relative total body iron stores [55]. Almost 1 µg/l of serum ferritin is equal to 8 mg of intercellular in iron stores [64, 78]. A measurement of serum ferritin is one of the recommended tests by the WHO for screening the iron deficiency [55]. According to this organization, the amount of serum ferritin of less than 15µg/l for women and adult men reflects the iron store depletion and the amount of ferritin more than 200µg/l for adult men and 150µg/l for adult women indicates the risk factors of iron overloads [55].

Serum iron reflects the portion of the iron in bloodstream that is attached to transferrin. In any case, this amount is less than 1% of the total body iron. Since, the serum iron has high circulating amount per day and it is influenced by factors like the amount of iron in the diet, thus, it cannot be consider as a good marker for the iron status [77, 79].

Transferrin is a protein, which transfers the iron, and it can be measured directly. Serum transferrin, an iron transport protein, increases when iron stores are low [80].

The soluble transferrin receptors are part of the transferrin extracellular receptors, which have been abandoned in plasma. They can be measured with laboratory methods and can be used as one of the parameters to evaluate iron status. The increased level of these receptors is a sensitive diagnostic marker to reduce the iron in the early stages of iron deficiency. Measurement of serum transferrin receptors was added to the iron body assay recently and is one of the tests recommended by the WHO for screening the iron deficiency [55].

CHAPTER 3
MATERIALS AND METHODS

3.1. Design and area of study

Investigating the reasons for the decreasing rate of whole blood donation at University Hospital Dusseldorf is one of the main concerns of the blood donation authorities.

Since iron deficiency is one of the reasons adduced for the reduction in the blood donation rate throughout the world, the main purpose of this study is to assess the donor's iron status as a probable reason for this decrement.

The present study was designed and proposed by the author and confirmed by Professor Giers as supervisor and leader of the blood donation center. The related proposal was accepted by Medical Research School.

3.2. Sample volume

During this study randomly 280 volunteer's data (inclusive 140 female and 140 male donors) have been analyzed with average age of 34.9 years (range 18-68 years) after receiving statement of University Ethic Commission at 18.07.2013 (Number:4344). The population study donated whole blood from October 1, 2012 through April 1, 2013. Among this population, 30 first-time donors and 250 frequent donors (people who had donated blood more than once) were set up and analyzed, with equal ratio of male to female donors.

The frequent donors were categorized into five groups of 50 donors (each 25 male and 25 female), based on the number of blood donation (Table.3.1). The average age of the first-time donors was 27.07 years (range 18-53 years). The frequent donors had an average age of 35.9 years (range 18-68 years).

Donation count	Male	Female	Percent	Valid Percent	Cumulative Percent
0	15	15	10.7	10.7	10.7
1-4	25	25	17.9	17.9	28.6
5-8	25	25	17.9	17.9	46.4
9-12	25	25	17.9	17.9	64.3
13-20	25	25	17.9	17.9	82.1
21-300	25	25	17.9	17.9	100.0
Total	**140**	**140**	**100.0**	**100.0**	

Table3.1.Study group distribution by donation count and gender

3.3. Blood donation process

All donors were pre-examined after answering the standard questionnaires (Appendix) and having their documentation controlled by educated nursing personnel. During this pre-examination, the vital signs such as heart rate, blood pressure, body temperature, and also weight and height were evaluated and capillary blood drops from finger prick were analyzed for hemoglobin concentration using the cyanmethemoglobin method with B-Hemoglobin photometer, HemoCue, Großostheim, Germany.

All of the donors complied with the necessary standards provided in German standard guideline for blood donation. (*Richtlinien zur Gewinnung von Blut und Blutbestandteilen und zur Anwendung von Blutprodukten (Hämotherapie)*) [5].

The next step forward was physical examining the volunteers who were donating blood for the first time. They were tested by the donation physician and were informed about the pros, cons, and procedure of blood donation.

Frequent donors were also interviewed briefly and re-examined after every 10 donation or every 2 years. Finally, the entire population was introduced to the phlebotomy and donation process.

3.4. Blood sample collection

During the process of blood donation, about 50 ml of blood volume is used for different

diagnostic tests in different Tubes. One of them is a 5ml violet EDTA, that used for complete blood test.
In the quality assurance and safety of blood product procedure, tubes, which the preliminary tests performed on them, are kept about two years at the temperature of $-30^{o}C$ until if it is needed to be reviewed again. Our specific tests for the iron indices are performed with thawing the frozen serum of donors.

3.5. Laboratory tests

3.5.1. Complete Blood Count (CBC)

This test is one of the public tests that performed for all donors as a part of blood donation process and its results are stored in the blood center data bank. Therefore, it was not needed to repeat this test and only the data from blood bank have been investigated. This test is performed with using blood from EDTA tube done by an advanced fully automated analyzer (SYSMEX K4500) with high ability to do hematological studies. The hemoglobin concentration is measured photometric and hematocrit value, red cell indices (mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH)) calculated automatically.
These parameters are mainly used for evaluating iron status in the body. Normal values of hemoglobin and hematocrit level, MCV and MCH are mentioned in Table.3.2.

3.5.2. Serum ferritin

The measurement of serum ferritin was conducted by means of Enzyme-linked Immunosorbent Assay (ELISA) test (using IMMULITE 100 ASSAYS SIEMENS), based on formation of antigen-antibody complex after passing many steps.
1 µg/L of ferritin in serum approximates to 8 mg of stored iron in reticuloendothelial system in the body [78]. The normal value and measuring unit of serum ferritin is shown in Table.3.2.
Low serum ferritin (<15µg/L), in addition to low hemoglobin or hematocrit, confirms the diagnosis of iron deficiency anemia [81].

3.5.3. Serum transferrin

Serum transferrin is an iron transport protein. Only 0.1% of total body iron is bound to transferrin at any time. The serum transferrin level of collected samples is evaluated using antisera against human transferrin and haptoglobin. This method is based on an immunochemical reaction between transferrin protein (as antigen) and specific antibodies. This test is performed turbidimetrically by BN ProSpec® System-Siemens. Normal values and measuring units of serum transferrin are shown in Table.3.2.

3.5.4. Serum transferrin receptor

Circulating soluble transferrin receptors (sTfR) can find in human plasma. An elevated serum transferrin receptor concentration (>8.5 mg/L) is an early and sensitive indicator of iron deficiency [62, 82]. sTfR was measured nephelometrically by BN™ II System - Siemens. This method is based on antigen-antibody reaction and is conducted by enzyme-linked immunosorbent assay (ELISA). Normal values of this examination are shown in Table 3.2.

3.5.5. Serum iron

Serum iron concentration is a measurement of circulating iron (Fe3+) bound to transferrin. Only 0.1% of total body iron is bound to transferrin at any time. During our investigation, serum iron assessment on collected samples was conducted by means of VITROS® 350 Chemistry System with photometric method. Normal values of serum iron are shown in Table 3.2.

3.6. Statistical analyses

After performing examinations, evaluation of the data was conducted with the statistical software SPSS (version 20) and R (version 3.0.1).

Parameter	Normal range/unit
Ferritin	11.7-302.7 (µg/L)
Transferrin	2.00-3.60 g/l
Serum iron	49-181 µg/dl
sTfR	0.81- 1.75 (mg/L)
Hemoglobin	12.3- 17.5 g/dl
Hematocrit	34.7- 48.2 (%)
MCV	83.0- 103.0 fl
MCH	27.0- 34.0 pg

Table 3.2.Hematologic parameter and iron indices unit reference range

CHAPTER 4

RESULTS

4.1. Hemoglobin

All of the donors represented hemoglobin levels ranging from 11.6 to 17.4 g/dl, with an average of 14.1 g/dl. Male donors' hemoglobin level was in the range of 12.6-17.4 g/dl, with mean of 15, and female donors' hemoglobin level was in the range of 11.6-15.9 g/dl, with mean of 13 (Table 4.4).

Before the donation process, donors underwent capillary blood sampling via the insertion of a needle into their index finger and subsequent spectrophotometer analysis. All donors exhibited normal values of hemoglobin for donating blood. But during our study, venous complete blood count analysis claimed that the hemoglobin level for 25 donors was lower than standard, but they were able to donate blood, despite the fact that the hemoglobin level was reported in the standard range using the spectrophotometry method (capillary blood sampling).These 25 donors consisted of 9 female donors (hemoglobin level: 12 g/dl) and 16 male donors (hemoglobin level: 13 g/dl).

This difference is a result of measurement error during spectrophotometer analysis and sampling from fingertips, in comparison with venous complete blood count analysis accuracy.

The relation between hemoglobin level and donors' gender was statistically significant ($P<2.2 *10^{-16}$) (Table 4.4). However, the relation between hemoglobin level and donors' age was not statistically significant (P 0.7277) (Table 4.6).

There was no significant correlation between the donation count and hemoglobin level (P 0.802) (Table 4.5). This indicates that as the blood donation count rises, we do not observe any fluctuation in hemoglobin levels. The relationship between hemoglobin level and blood donation count is indicated in fig.4.1.

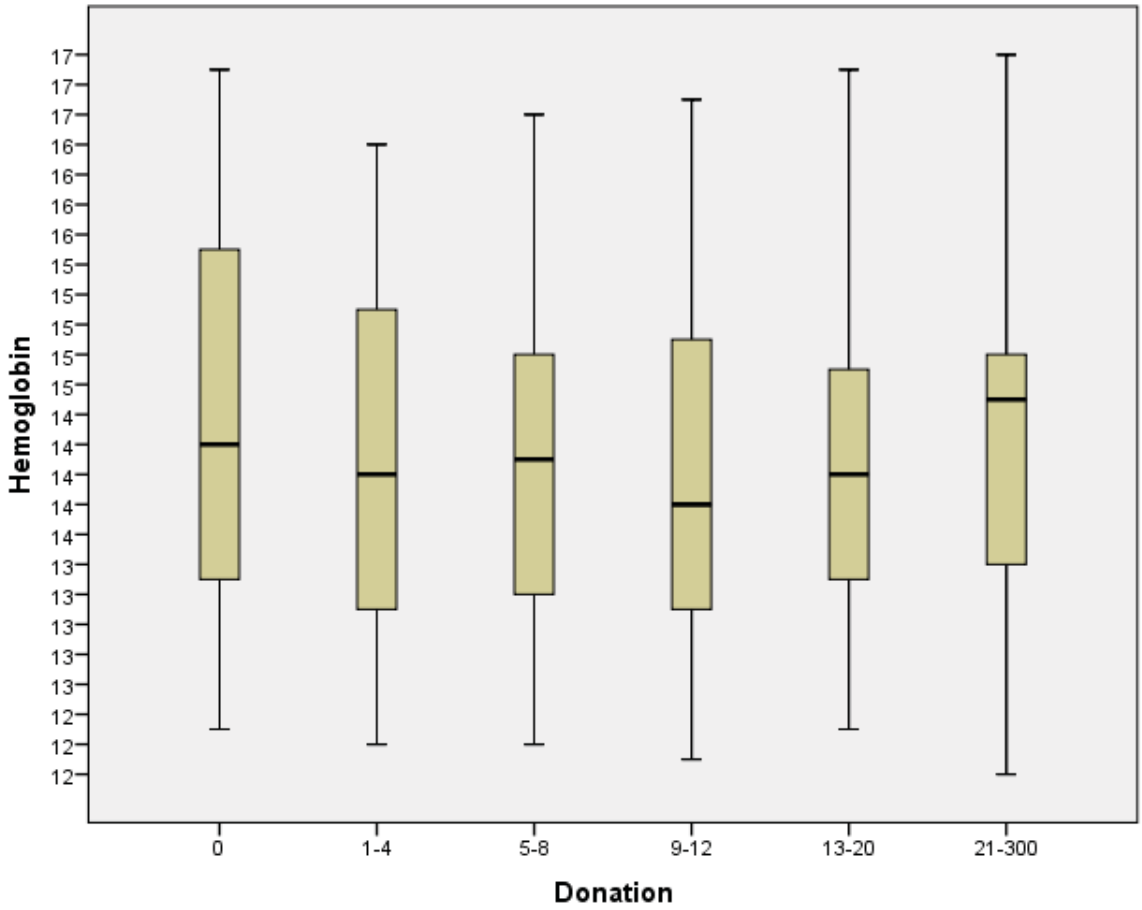

Fig. 4.1.Hemoglobin by donation count

4.2. Hematocrit

All of the donors represented hematocrit values in the range of 35-52%, with mean of 41%. Male donors' hematocrit level ranged from 38 to 52%, with an average of 43%, and female donors' hematocrit levels ranged from 35 to 46%, with an average of 40% (Table 4.4). The relevance between hematocrit level and donors' gender was statistically significant ($P < 2.2*10^{-16}$) (Table 4.4).

There was no statistically significant correlation between hematocrit level and donors' age (P 0.7166) (Table 4.6).

No significant relationship was observed between hematocrit level and blood donation count (P 0.785) (Table 4.5). This suggests that hematocrit level is independent from blood donation count variations. The relationship between hematocrit level and blood donation count is shown in fig 4.2.

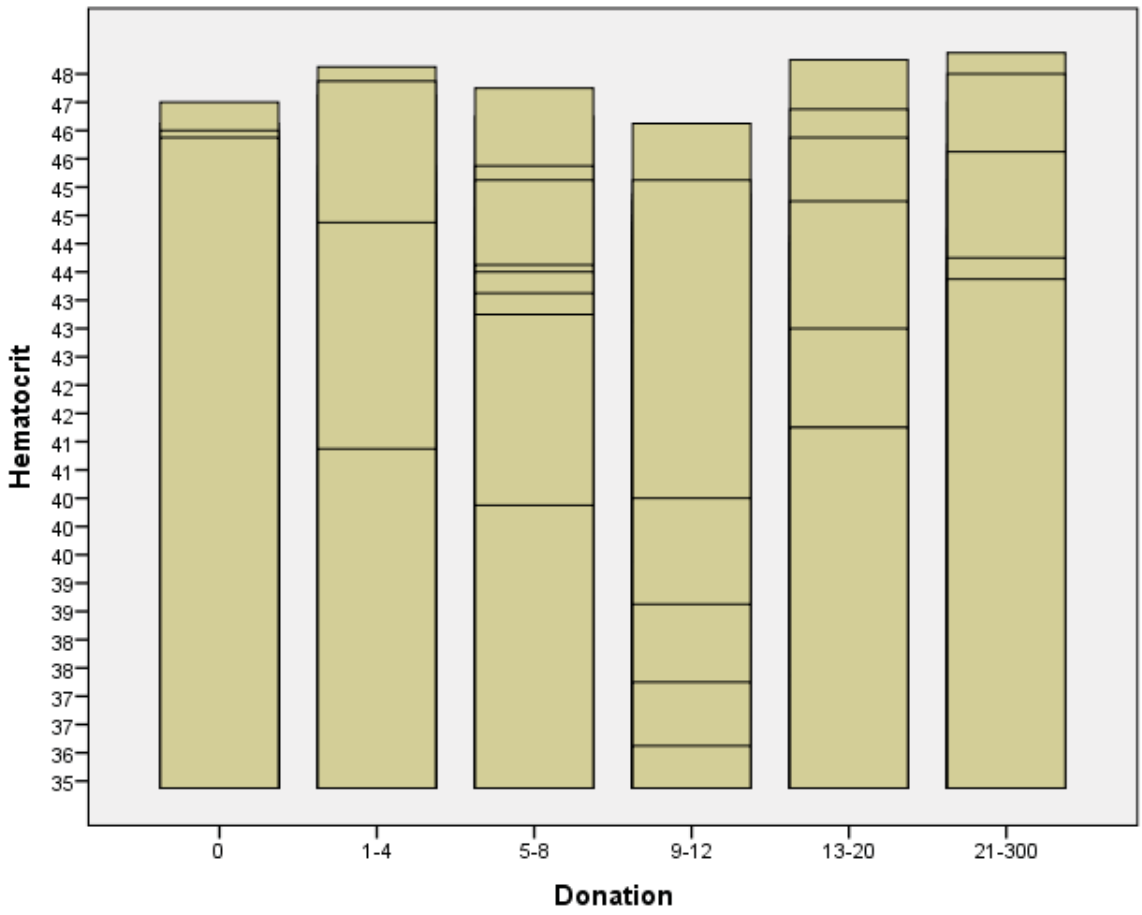

Fig. 4.2.Hematocrit by donation count

4.3. Mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH)

Measured mean corpuscular volume (MCV) for each donor was in the range of 34.9-96 fl, with mean of 85.57 fl. Male donors' MCV was reported in the range of 73.9- 95.9 fl, with an average of 85.32 fl, and female donors' MCV was reported in the range of 34.9- 96 fl, with an average of 85.82 fl (Table 4.4).

Considering different variables (gender, age, and blood donation count), the only significant relationship was established between MCV and donor's age (P 0.0018) (Tables 4.4, 4.5, 4.6).

Measured mean corpuscular hemoglobin (MCH) for each donor was in the range of 23.5-34.3 pg, with an average of 30 pg. Male donors' MCH was reported in the range of 23.5-34.3 pg, with mean of 29 pg and female donors' MCH was reported in the range of 23.7-

32.8 pg, with an average of 29 pg. Considering different variations (age, gender, and blood donation count) and MCH level, no significant correlation was established (Tables 4.4, 4.5, 4.6).

4.4. Ferritin

Measured serum ferritin level for all donors ranged from 2 to 464 µg/l, with an average of 43 µg/l. Male donors' serum ferritin values ranged from 5 to 464 µg/l, with an average of 56 µg/l and female donors' serum ferritin values ranged from 2 to 222 µg/l, with an average of 30 µg/l (Table 4.4).

A significant relationship was observed between ferritin level and donor's gender ($P<0.05$) (Table 4.4). 95% confidence interval for serum ferritin distribution based on donor's gender is illustrated in fig .4.3.

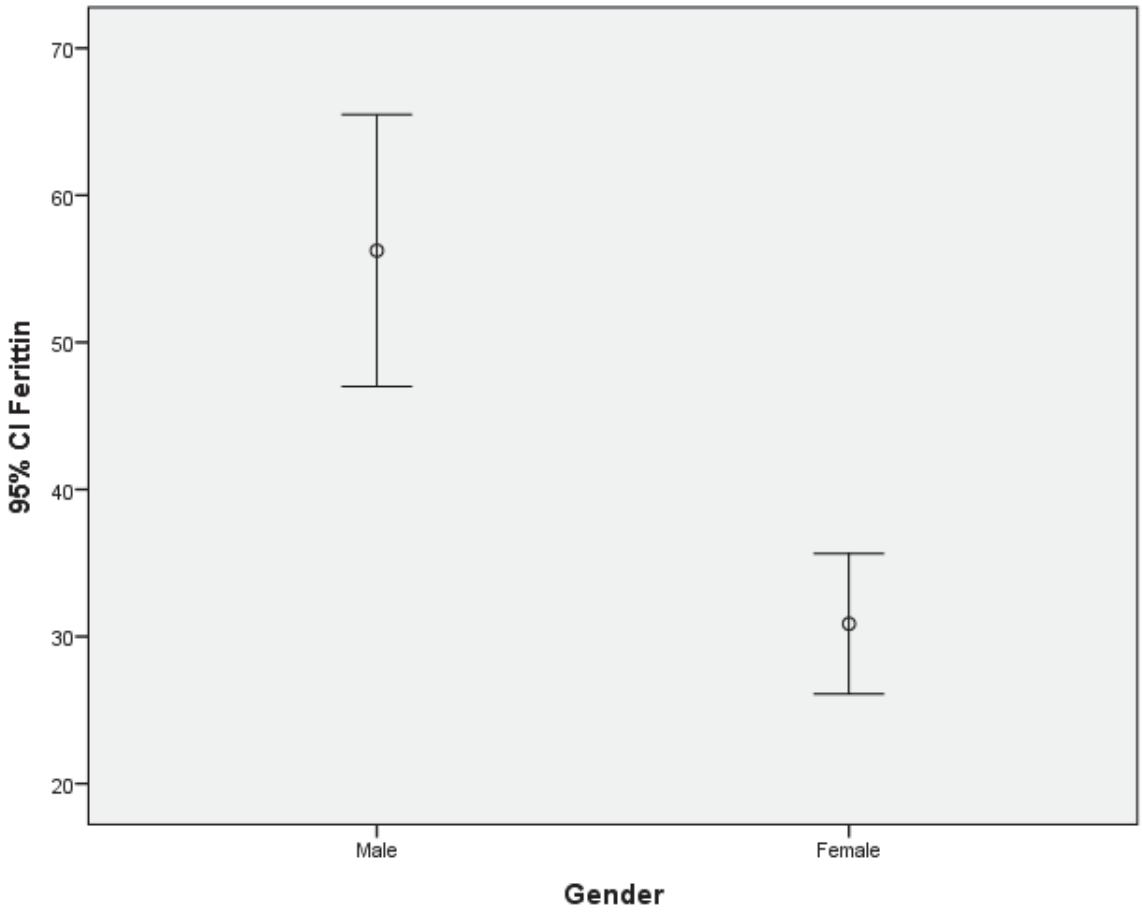

Fig. 4.3.Serum ferritin by gender

There was a significant relationship between serum ferritin level and the number of blood donation: as the blood donation count increases, serum ferritin level decreases (P 0.0000691) (Table 4.4).

95% confidence interval for serum ferritin distribution based on the blood donation count is illustrated in fig.4.4.

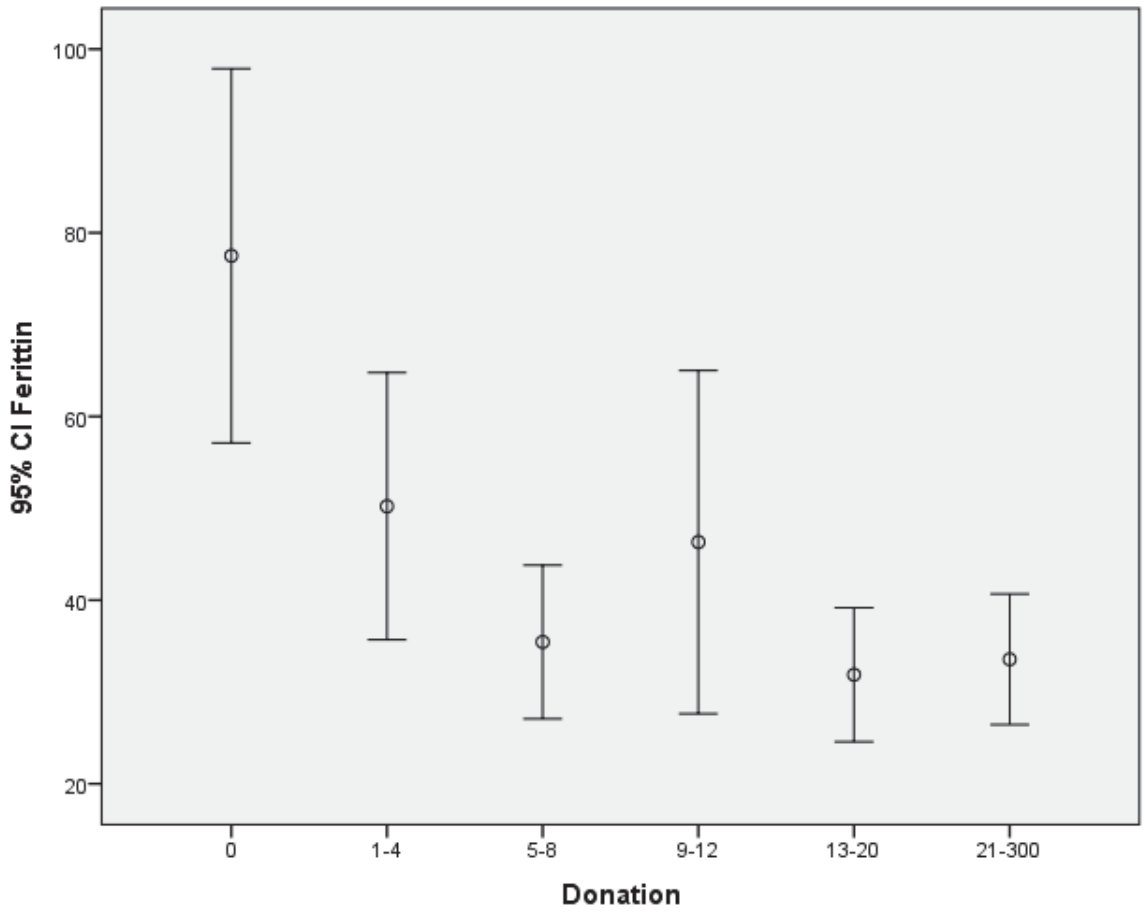

Fig. 4.4.Serum ferritin by donation count

As mentioned before, in serum ferritin less than 15µg/l, the body iron stores are depleted, and the functional iron bound to transferrin is only in the blood.

In our study, depleted iron stores were seen in a total of 61 donors (21.77% of the whole examined population). This rate is based on donor's gender, including 28.57% (40 of 140) female volunteers and 15% (21 of 140) male volunteers. This demonstrates that women

experience over twice the rate of iron store deficiency than men.

The number of donation also plays a substantial role in serum ferritin level changes. Among the volunteers who donated blood for the first time, there was only one woman whose ferritin was assessed at less than 15µg/l. The remaining 60 donors who exhibited iron store deficiency were from the frequent donor group (donors who donated blood more than once).

In frequent donors, as predicted, when the number of donations increases we observe a significant decrease in serum ferritin levels. During our examinations, we found that 26% of donors who had donated blood more than 5 times had depleted iron stores. Serum ferritin level distribution, based on donation count is illustrated in Table 4.1.

Ferritin	0	1-4	5-8	9-12	13-20	>=21	number	%
<10	1	4	3	4	3	3	18	6.42
10.14	0	4	9	9	14	7	43	15.35
15.30	6	18	15	13	13	19	84	30
31.60	7	8	14	13	12	13	67	23.92
>=61	16	16	9	11	8	8	68	24.28
Total	30	50	50	50	50	50	280	100

Table 4.1.Serum ferritin by donation count

No significant relationship has been seen between serum ferritin level and donor's age range (P 0.6144) (Table 4.6).

4.5. Serum iron

Serum iron values for all donors ranged from 19 to 306 µg/dl, with an average of 105 µg/dl. Male donors' serum iron values ranged from 21 to 306 µg/dl, with an average of 109 µg/dl, and female donors' serum iron values ranged from 19 to 301µg/dl, with an average of 101µg/dl (Table 4.4).

There was no significant relationship between serum iron values and donor's gender (P

0.2315) (Table 4.4).

No significant relationship was found between serum iron level and number of donation (P 0.831) (Table 4.5). This indicates that no remarkable changes occur to serum iron level when the donation count rises. The relationship between serum iron level and blood donation count is shown in fig. 4.5.

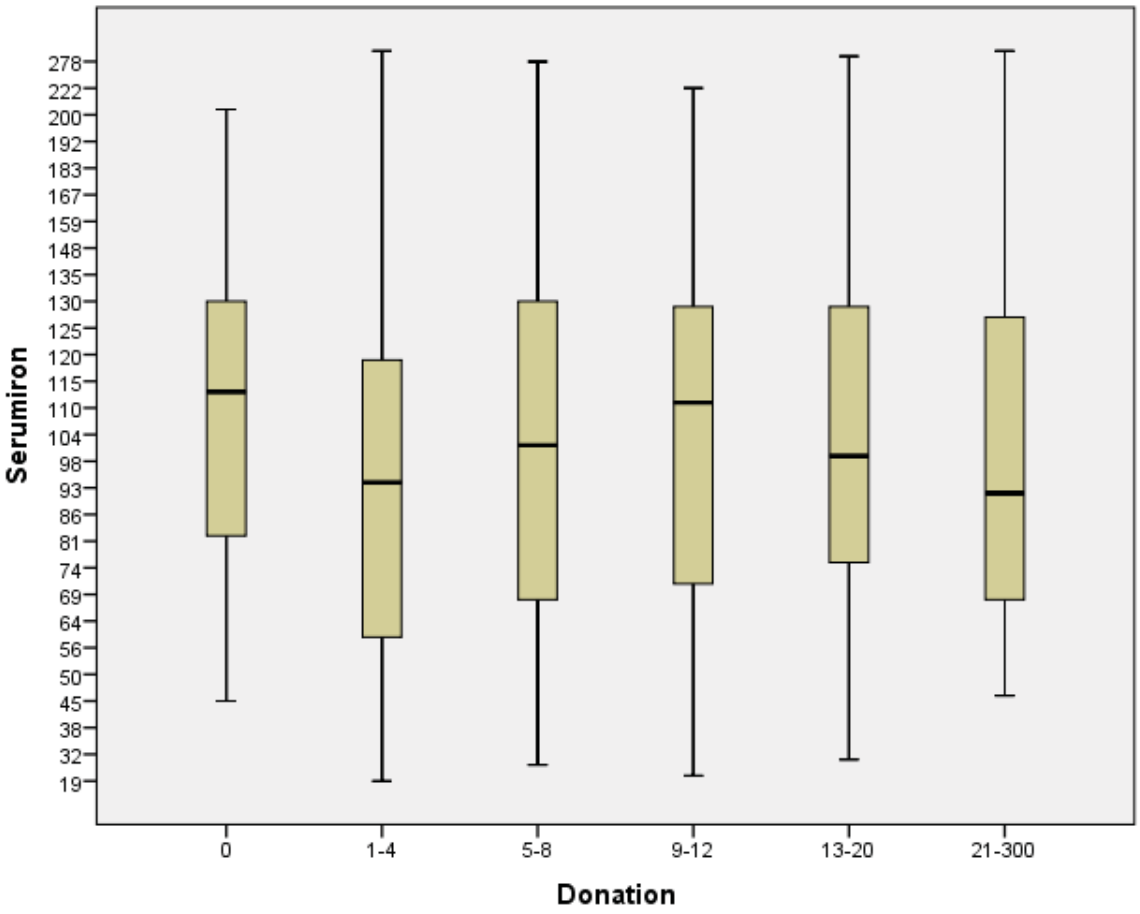

Fig. 4.5.Serum iron by donation count

No significant correlation was seen between serum iron level and donors' age (P. 0.9998) (Table 4.6). Compared with the normal range of serum iron level (49-181 µg/dl) (Table 3.2), 31 donors out of the volunteer population (11.07%) exhibited a serum iron level lower than 49 µg/dl. The gender distribution was as follows: female donors 23 out of 180

(12.7%), male donors 8 out of 180 (4.44%). Serum iron level reduction in the female donor population occurs almost 2.8 times more often than in the male donor population. 26 donors (9.28%) out of the entire volunteer population exhibited a serum iron level greater than 181µd/dl. (Table 4.2).

Serum iron	Male	Female	First-time	Frequent	number	%
1-48	8	23	1	30	31	11.07
181-49	118	105	25	198	193	79.65
>=182	14	12	4	22	26	9.28
Total	140	140	30	250	280	100

Table 4.2.Serum iron by gender and donation count

32% of donors whose ferritin level was reported as less than 15µg/l had measured serum iron levels lower than the necessary standards. However, there was no significant correlation between serum iron level and serum ferritin level.

4.6. Transferrin

The serum transferrin level in the entire volunteer population ranged from 1.9 to 4.7 mg/dl, with mean of 2.9 mg/dl. Male donors' serum transferrin ranged from 2 to 3.7 mg/dl, with mean of 2.9 mg/dl and female donors' serum transferrin ranged from 1.9 to 4.7 mg/dl, with mean of 3 mg/dl. No significant correlation was seen between serum transferrin level and donors' gender (P 0.005548) (Table 4.4).

95% confidence interval for serum transferrin distribution based on donors' gender is illustrated in fig .4.6.

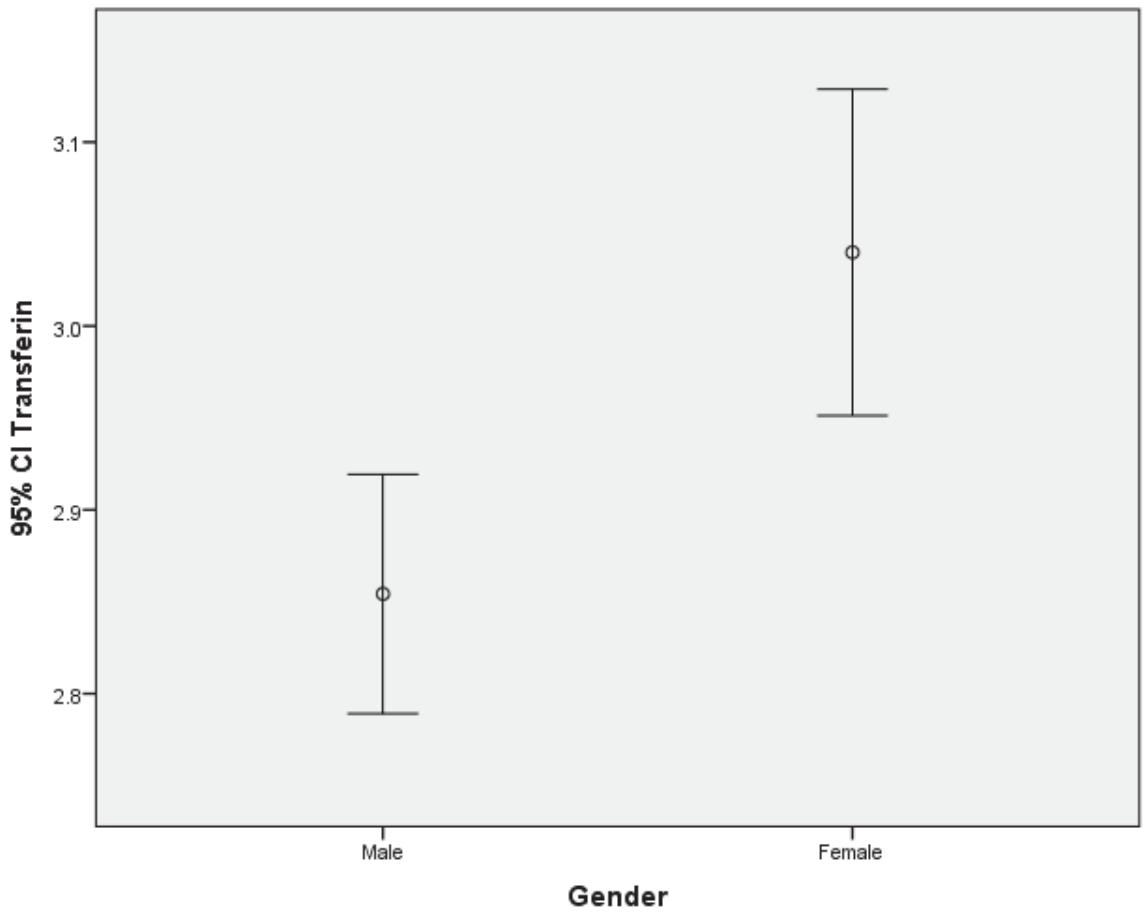

Fig. 4.6.Serum transferrin by gender

No significant relationship exists between serum transferrin level and the number of donation (P 0.935) (Table 4.5). This demonstrates that the increment of blood donation count did not directly affect the serum transferrin level. Fig.4.7 illustrates the correlation between serum transferrin distribution and donation count.

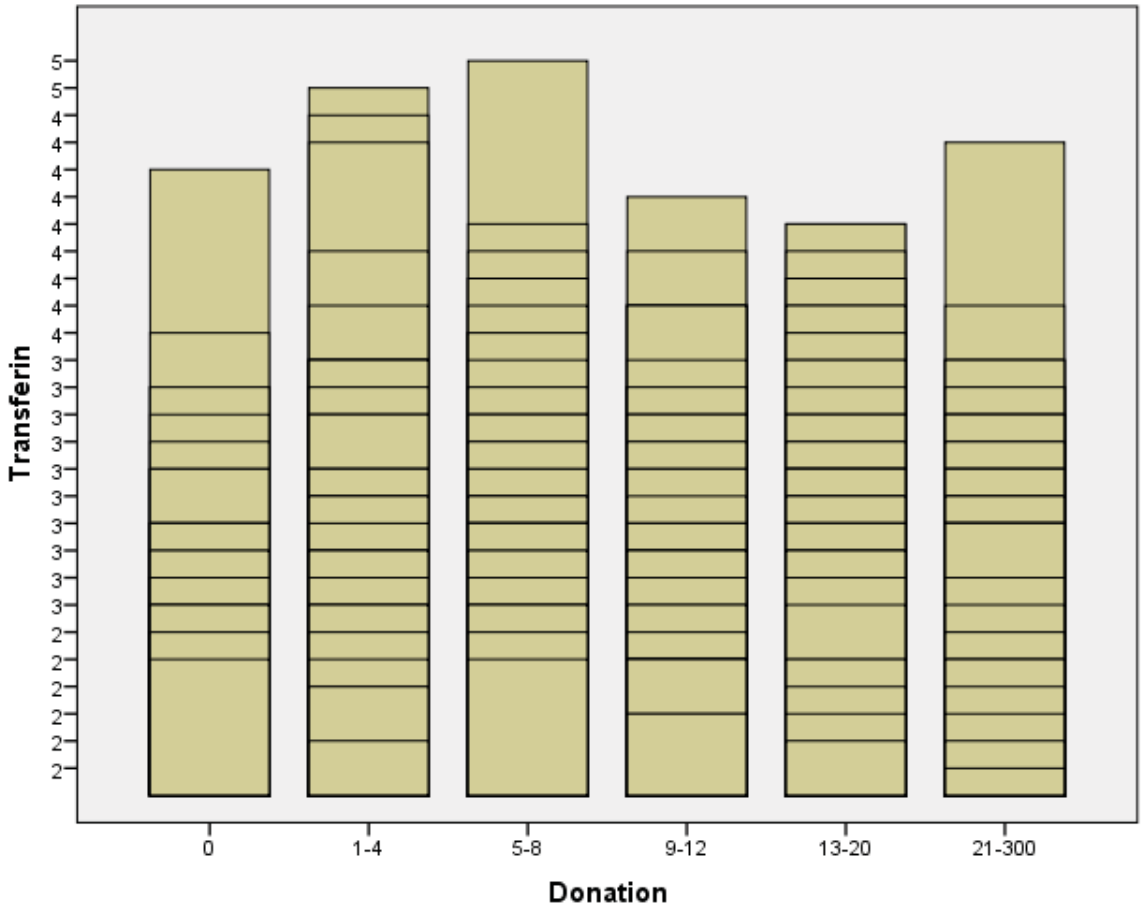

Fig. 4.7.Serum transferrin by donation count

The relationship between serum transferrin level and donors' age was statistically significant (P 0.024) (Table 4.6). It means that in older donors we confronted lower levels of serum transferrin. Fig.4.8 shows the relationship between serum transferrin distribution and donors' age.

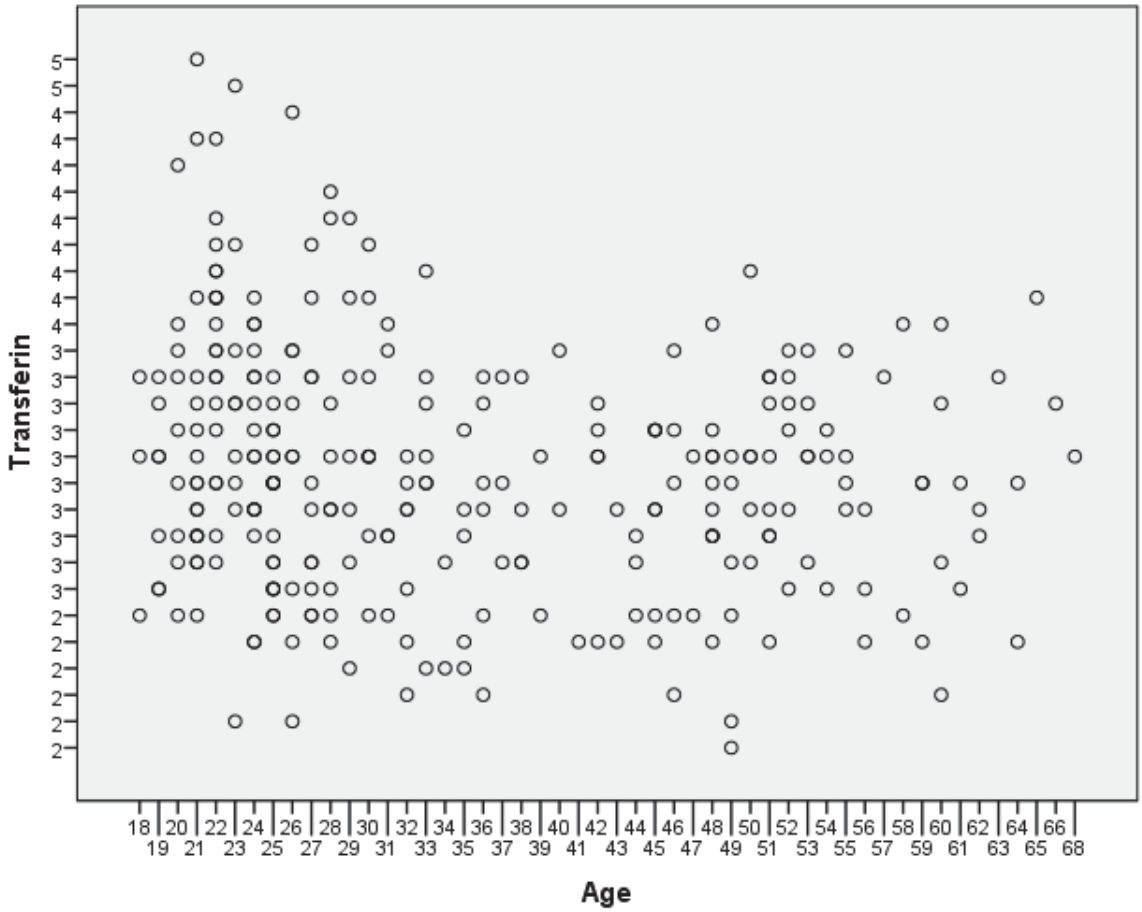

Fig. 4.8.Serum transferrin by age

Compared with the normal range of serum transferrin (2.00 to 3.60 g/l), only one of our frequent female donors exhibited a serum transferrin level lower than standard. 18 donors out of the entire volunteer population (6.4%) were reported to have a serum transferrin level greater than standard. These 18 donors were distributed, based on blood donation count, as follows: 1 donor, first time donation and 17 donors, frequents donation. These 18 donors' consisted of 16 female donors and 2 male donors (Table 4.3).

serum transferrin	Male	Female	First-time	Frequent	number	%
<2	0	1	0	1	1	0.35
2-3.6	138	123	29	232	261	93.2
≥ 3.7	2	16	1	17	18	6.4
Total	140	140	30	250	280	100

Table 4.3.Serum transferrin by gender and donation count

4.7. Soluble transferrin receptors (sTfR)

The volunteer population as a whole represented soluble transferrin receptor levels ranging from 0.5 to 3.2 mg/l, with mean of 1.2 mg/l (Table 4.4).

Male donors' soluble transferrin receptor values ranged from 0.5 to 3.2 mg/l, with mean of 1.3 mg/l, and female donors' soluble transferrin receptor values ranged from 0.5 to 2.8 mg/l, with mean of 1.2 mg/l (Table 4.4).

The relationship between serum transferrin receptor level and donors' gender was not statistically significant (P 0.2191) (Table 4.4).

There was no significant correlation between soluble transferrin receptor level and donor's age (P 0.5403) (Table 4.6).

The correlation between soluble transferrin receptor level and number of donation was not statistically significant (P 0.357) (Table 4.5). This indicates that the increment in the blood donation count has no significant effect on the soluble transferrin receptor level.

The relation between soluble transferrin receptor level and blood donation count is reflected in fig. 4.9.

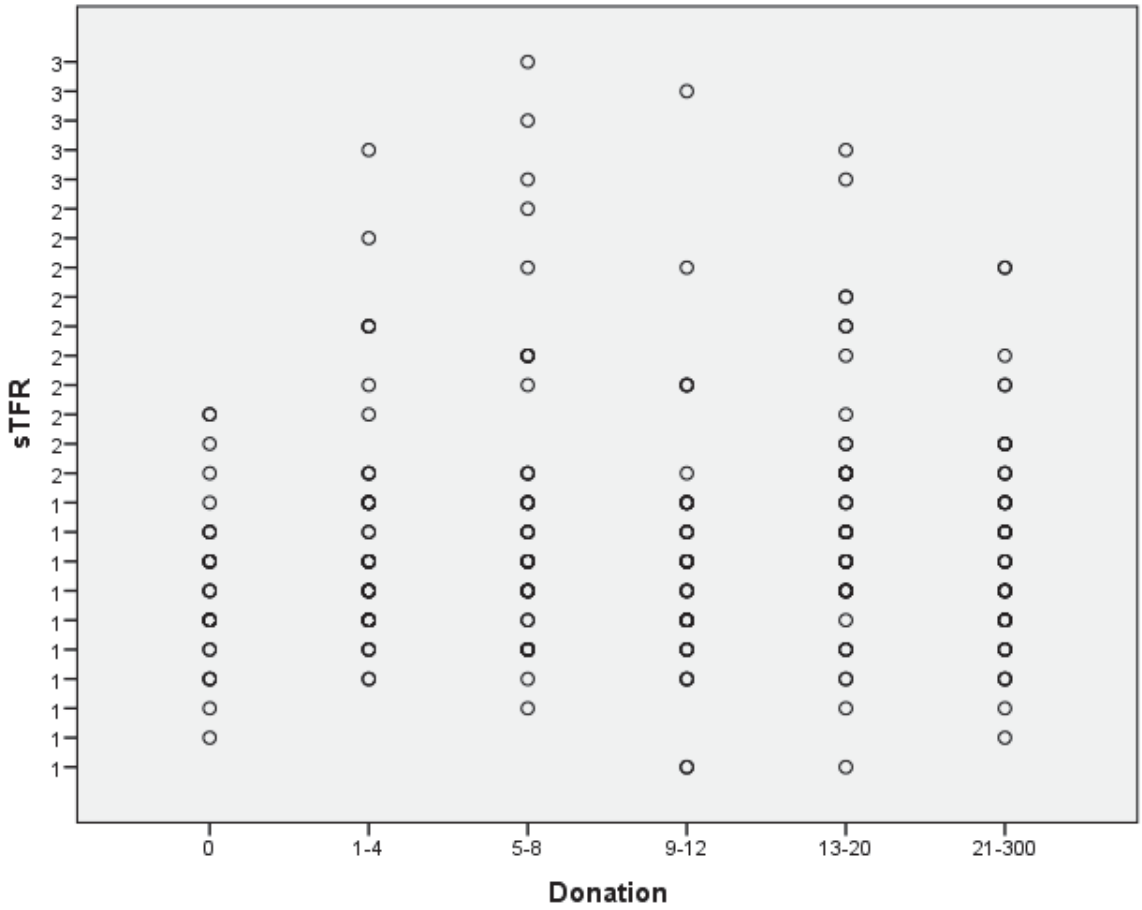

Fig. 4.9.Soluble transferrin receptors by donation count

In comparison with the normal range of serum soluble transferrin receptor level (0.8-1.75 mg/l) (Table 3.2), 20 donors (7.14%) represented standard levels of soluble transferrin receptors, and 260 donors (92.8%) exhibited soluble transferrin receptor levels lower than necessary standards. Measured values of soluble transferrin receptors were greater than standards in none of the donors.

Parameter (unit)	Men(n=140)	Women(n=140)	Total(n=280)	Pvalue
Ferritin(µg/L)	5, 464 56.243 (40)	2, 222 30.868 (22)	2, 464 43.556 (29)	0.0000000948
Transferrin g/l	2.0, 3.7 2.854	1.9, 4.7 3.040	1.9, 4.7 2.947	0.005548
Serum iron µg/dl	21, 306 109.086	19, 301 101.957	19, 306 105.521	0.2315
sTfR(mg/L)	0.5, 3.2 1.3086	0.5, 2.8 1.233	0.5, 3.2 1.271	0.2191
Hemoglobin g/dl	12.6, 17.4 14.836	11.6, 15.9 13.394	11.6, 17.4 14.115	$< 2.2 \times 10^{-16}$
Hematocrit (%)	37.6, 52.0 43.157	35.3, 46.2 39.762	35.3, 52.0 41.460	$< 2.2 \times 10^{-16}$
MCV fl	73.9, 95.9 85.324	34.9, 96.0 85.826	34.9, 96.0 85.575	0.01615
MCH pg	23.5, 34.3 29.366	23.7, 32.8 29.149	23.5, 34.3 29.258	0.2114

Table 4.4.Mean iron indices, Hb, Hct, MCV, MCH by gender

Parameter (unit)	0(n=30)	1-4 (n=50)	5-8 (n=50)	9-12 (n=50)	13-20 (n=50)	>=21 (n=50)	Total (n=280)	Pvalue
Ferritin(µg/L)	10, 211 77.50 (70.5)	3, 222 50.22 (28.5)	4, 144 35.44 (27.5)	5, 464 46.32 (27.5)	2, 108 31.88 (21.5)	6, 129 33.55 (27.5)	2, 464 43.556 (29)	0.0000691
Transferin g/l	2.3, 4.2 2.84	2.0, 4.6 2.97	2.3, 4.7 3.05	2.1, 4.1 2.91	2.0, 3.9 2.99	1.9, 4.3 2.89	1.9, 4.7 2.947	0.935
Serum iron µg/dl	45, 207 113.6	19, 306 97.52	26, 278 108.64	21, 222 107.62	28,301 105.76	46, 306 103.22	19, 306 105.521	0.831
sTfR(mg/L)	0.6, 1.7 1.12	0.8, 2.7 1.28	0.7, 3.2 1.36	0.5, 2.9 1.20	0.5, 2.7 1.35	0.6, 2.2 1.25	0.5, 3.2 1.271	0.357
Hemoglobin g/dl	12.3, 17.1 14.39	12.2, 16.2 14.09	12.2, 16.5 14.01	12.1, 16.6 14.02	12.3, 17.1 14.07	11.6, 17.4 14.22	11.6, 17.4 14.115	0.802
Hematocrit (%)	33.5, 46.8 41.94	35.3, 48.8 41.24	37.4, 47.0 41.44	36.2, 46.2 41.10	36.5, 49.0 41.26	36.7, 52.0 41.97	35.3, 52.0 41.460	0.785
MCV fl	81.8, 92.9 86.57	37.8, 95.9 85.19	34.9, 96.0 83.99	73.3, 95.8 86.43	74.7, 94.4 84.74	76.1, 94.9 86.93	34.9, 96.0 85.575	0.438
MCH pg	27.0, 32.1 29.67	26.4, 32.8 29.40	24.6, 31.9 28.68	23.5, 33.6 29.48	24.8, 32.2 28.97	23.7, 34.3 29.51	23.5, 34.3 29.258	0.796

Table 4.5.Mean iron indices, Hb, Hct, MCV, MCH by donation count

Parameter (unit)	18-24(n=80)	25-34-(n=83)	35-44(n=33)	45-54(n=57)	55-68(n=27)	Total(n=280)	Pvallue
Ferritin(µg/L)	3, 214 40.74 (26.5)	2, 173 43.41 (31)	10, 211 48.88 (29)	6, 464 42.34 (28)	9, 222 48.41 (33)	2, 464 43.556 (29)	0.6144
Transferrin g/l	2.0, 4.7 3.14	2.0, 4.4 2.92	2.1, 3.4 2.76	1.9, 3.7 2.86	2.1, 3.6 2.87	1.9, 4.7 2.947	0.0024
Serum iron µg/dl	19, 278 98.05	28, 306 117.73	41, 200 93.82	46, 211 100.65	49, 306 114.74	19, 306 105.521	0.9998
sTfR(mg/L)	0.7, 2.9 1.34	0.6, 3.2 1.26	0.5, 2.2 1.16	0.5, 2.7 1.24	0.8, 2.2 1.32	0.5, 3.2 1.271	0.5403
Hemoglobin g/dl	12.2, 16.7 13.97	12.1, 17.4 14.21	12.5, 16.3 14.56	11.6, 16.7 13.98	12.8, 15.5 13.98	11.6, 17.4 14.115	0.7277
Hematocrit (%)	35.5, 46.9 41.26	35.3, 52.0 41.44	37.4, 46.1 42.27	36.2, 47.5 41.32	38.0, 44.5 41.44	35.3, 52.0 41.460	0.7166
MCV fl	75.0, 93.9 84.89	34.9, 95.9 84.48	78.8, 94.2 85.98	76.1, 95.8 86.66	77.8, 96.0 88.20	34.9, 96.0 85.575	0.0018
MCH pg	24.5, 32.3 28.72	23.5, 32.8 29.41	27.0, 34.3 29.68	23.7, 33.6 29.32	25.9, 32.2 29.76	23.5, 34.3 29.258	0.0474

Table 4.6.Mean iron indices, Hb, Hct, MCV, MCH by age

CHAPTER 5
SUMMARY, CONCLUSION, AND RECOMMENDATION

5.1. Summary:

This study has been evaluated to follow the iron status of blood donors to see whether iron deficiency could be one of the possible reasons for the decrease statistic of blood donation in Dusseldorf University Hospital.

Unfortunately, assessment of iron status is not included in the routine screening of blood donation due to financial issues. Now in the most of blood donation centers, the donors' iron status is guessed with measuring indirectly the hemoglobin concentration by finger prick blood sampling.

Although, measuring hemoglobin is simple, fast and low cost, but it cannot be solitary criterion for body iron estimation. However, this method is highly dependent on the skill of the examiner person. For iron status estimation, specific tests are needed to carry out where each of them is looking at the iron body in different aspect.

The process of iron deficiency is a time consuming action. It shows itself at first by reducing iron stores and functional iron and in advanced stage appears with reducing the production of hemoglobin that causes iron deficiency anemia. In this case, drop in hemoglobin can be visible.

Accordingly, there may be blood donors who are at the early stages of iron deficiency whom have allowed hemoglobin level to donate blood but their iron stores are depleted. Eventually, after several consecutive donations without iron replacement, their hemoglobin value fall below cut-off for blood donation. For this reason, they are not permitted to donate for the next time and this could cause the reduction in the statistics of blood donation.

Previous studies have shown that in every blood donation between 200 to 250 mg of body iron stores is lost. For this reason, many believe that blood donation is "iron donation".

Blood donation deplete iron stores and reduce ferritin level faster and more than all the other reasons. That is why most of the studies on the effects of blood donation on iron have been conducted to evaluate the serum ferritin.

In this study, in addition to ferritin, other iron indices such as transferrin, transferrin receptors and serum iron have been measured so far.

Serum ferritin concentration, in comparison with other laboratory parameters, represents a stronger relationship with the blood donation count. So in conditions where comprehensive laboratory testing is impossible, serum ferritin concentration (in the absence of any infection) can be taken to reflect the body's iron stores.

Based on the obtained results, the only statistically significant relationship among all the variables reviewed was seen to be between serum ferritin levels and the number of donations (P 0.000).

In our study, 21.77% (61 of 280) of all donors had depleted iron store (serum ferritin less than 15µg/l). This rate is based on donor's gender, including 28.57% (40 of 140) female volunteers and 15% (21 of 140) male volunteers. This indicates that iron store deficiency in female donors occurs some two times more frequently than in male.

The donation count also plays a substantial role in serum ferritin level changes. Among the volunteers who donated blood for the first time, there was only one donor (female) whose ferritin was assessed at less than 15µg/l. All the other 60 donors who exhibited depleted iron store were from the frequent donor group (donors who donated blood more than once). This suggests that as the blood donation number increases, serum ferritin level decreases.

Fortunately, numerous studies have been carried out about frequent blood donation effects on iron status. Previous studies by ferritin measurement affirmed that iron stores obviously decrease as a result of frequent blood donation [83, 84, 85, 86, 87]. Table 5.1 indicates some of these studies.

As the table below is taken, the iron depletion regardless of gender and statistics of blood donations at a glance is vary between the different countries. Another interesting point is that in the Alvares et al study of 15 years ago at a university of Lübeck (Germany) the amount of iron depletion in donors were 21.79% and in this work, this amount is about 21.77%. This strange similarity in the results is perhaps due to consistent of environmental conditions or could be justify with other reasons.

Study	Year	Country	Depleted iron stores (%)				
			Overall	Male	Female	First-time	Frequent
Goldman et al. [98]	2012	Canada	17.8	16.4	27.1		
Zaccheaus et al. [90]	2010	Niger	20.6	11			
Wood et al. [96]	2011	Australia	22.6				
Richard Cable et al. [94]	2012	USA	15	16.4	27.1		43.5
Norashikin [89]	2006	Malaysia		11			11
Mital et al. [93]	2006	India		33	57.8		45.4
Alvares et al. [88]	1999	Germany	21.79	20.15	24.73	5	26
Milman [91]	1996	Denmark			31.7		
Milman et al. [92]	1985	Denmark			22.1	22.1	31.5
Simon et al. [87]	1981	USA		8	38		46
Nadarajan et al. [95]	2002	Malaysia		15.7	22.7	7.4	17.4
Romilla Mittal . [100]	2006	India		33	57.6	33.5	51.25

Table 5.1.Summary of studies about blood donation effects on donor's body iron stores

5.2. Conclusion:

According to the results obtained, it can be mentioned that first that the result of this study is based on international experiences and confirms previous studies on the impact of frequent blood donation on depletion of iron body storage. Secondly, iron deficiency, which in its early stages shows iron depletion, can be one of the reasons for decrease in the number of blood donation in the University Hospital Dusseldorf. As a result donors who are at this stage and do not receive replaced iron, in the near future can become close to the last stages of iron deficiency which is iron deficiency anemia and their hemoglobin level can be set lower than the standard value. Hence, they would not be able to donate anymore.

It has been evaluated as if donors had been deferred for low hemoglobin then they would approximately donate 30% less blood for 4-5 years than the donors who have not been deferred [99].

This is especially important for frequent donors who are donating more blood and female donors who vocalize the majority of donors. In addition, women are more susceptible to iron deficiency. They need more iron than men because of their physiological needs.

According to latest statistics, the incidence of blood donation attempt deferral due to low hemoglobin level in whole blood donors visiting Dusseldorf University Hospital in 2012 was 6.8% (11.8% of female and 2.9% of male donation attempts).

It is clear that in the absence of iron substitution, this rate will rise in coming years and the total blood donation ratio will fall year by year.

Overall, regarding to the fact that this work was the first study on the effects of blood donation on body iron of donors in the hospital, it can be said that the result is clearly rational and noteworthy. This means that if the aim is to prevent from decrease in blood donation, the donors iron status should be more controlled. It is hoped that this project could be a starting point for further research projects in this field.

To carry out this research, it was also faced with some problems such as:

1. The absence of a research& consulting center to help students in their original design of research

2. Difficulty in finding an experienced supervisor that has the capacity of taking doctoral students and has enough time
3. Registration process and review of the proposal and finished projects at university is too long, that is why most of the people are giving up to continue after starting
4. Conducting a research project requires adequate funding. Unfortunately, there are so many limitations in this area.
5. Unfortunately, until now no studies had been done in the context of this research at the university. In other word, no basic information was available about the effects of blood donation to compare with the results of this work. The only available statistics is the retrospective review of the number of deferred donation because of low hemoglobin in 2012, which is also carried by this author.

5.3. Recommendation:

Blood donation and iron donation are interdependent. Without having enough iron, blood donation is not possible and blood without iron is not effective. Due to the verified effects of blood donation on decrease of iron stores, it is necessary to put donor's iron control in the program of continuous monitoring of the health of donors.

It appears that the following practical solutions can be helpful in this way:

1. Since the hemoglobin level cannot be indicative of body iron status, it is necessary to measure iron stores frequently in the program of screening blood donors regardless of the hemoglobin concentration. For example, in first-time donors serum ferritin level should be assessed in order to inform us about the donor's iron store basis. In frequent donors, especially female donors, ferritin levels should be evaluated at appropriate intervals, in order to determine blood donation effects on iron stores. This evaluation can be conducted at least once a year for each donor, or after 6 donations for male donors, and after 4 donations for female donors.
2. Decision for Blood donation should not be only based on measuring hemoglobin level before donation, and the measured serum ferritin for the permitted blood donation should be considered too.

3. Auxiliary supplemental iron could be given along with adequate training to donors who have lip hemoglobin border or their ferritin level is low.
4. Directory of the blood donation in Germany considered the annual allow able blood drive in men and women is about 3000 and 2000 ml, respectively. 8 week minimum distance allowed between two donations. It seems that not all of donors can replace iron lost in this meantime. Therefore, increasing the interval between successive donations can be another effective strategy for restoring iron in many donors.

CHAPTER 6
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CHAPTER7
APPENDIX

BLOOD DONATION QUESTIONAIRE

HEINRICH HEINE
UNIVERSITÄT DÜSSELDORF

Universitätsklinikum Düsseldorf
Institut für Haemostaseologie und Transfusionsmedizin
Direktor: Univ.-Prof. Dr. R. E. Scharf F.A.H.A.
Blutspendezentrale des UKD
Telefon: (0211) 81 - 18575
Spendezeiten: Mo. - Fr. von 7.00 bis 12.00 Uhr, Di. und Do. von 14.00 bis 18.00 Uhr

Bitte lesen Sie diese Information anlässlich jeder Blutspende vor Ausfüllen des Fragebogens aufmerksam durch!

Verehrte Blutspenderin verehrter Blutspender!
Viele große medizinische Fortschritte sind heute nur möglich, wenn menschliches Blut in ausreichender Menge zur Verfügung steht. Durch einen Unfall oder eine schwere Erkrankung kann jeder plötzlich in die Lage geraten, Bluttransfusionen zu benötigen. Deshalb ist es so wichtig, dass jeder gesunde Erwachsene soziales Engagement zeigt, indem er Blut spendet.
Blut besteht im Wesentlichen aus drei Bestandteilen: den roten Blutkörperchen (Erythrozyten), die den Sauerstoff im Körper transportieren, den Blutplättchen (Thrombozyten), die bei Verletzungen einen Pfropf zum Wundverschluss bilden und der Blutflüssigkeit (Plasma), die lösliche Gerinnungsfaktoren enthält, die bei der Verfestigung des Blutpfropfes helfen. Diese Blutkomponenten werden bei großem Blutverlust (z.B. nach Unfällen, großen Operationen), bei angeborenen oder erworbenen Blutbildungsstörungen (z.B. nach Chemotherapie) oder bei Störungen der Blutgerinnung (z.B. Bluterkrankheit) benötigt und eingesetzt. Es gibt zwei verschiedene Arten, Blut zu spenden:
1. Das "Vollblut" wird in ein Beutelsystem entnommen und anschließend in verschiedene Bestandteile getrennt.
2. Das "Vollblut" wird über eine Maschine (Separator) entnommen und sofort in verschiedene Bestandteile zerlegt. Der gewünschte Anteil, z.B. Plasma (Plasmapherese) oder Thrombozyten (Thrombozytapherese), wird gewonnen; die anderen Bestandteile erhält der Spender wieder zurück.

Um alle denkbaren Gesundheitsrisiken für Blutspender und Blutempfänger auszuschließen, ist es notwendig, anhand von Informationen über Ihren bisherigen Gesundheitsverlauf, ggf. einer körperlichen Untersuchung und einigen Blutuntersuchungen einen Eindruck über Ihre Spendefähigkeit zu gewinnen. Daher bitten wir Sie, zunächst die nachfolgenden **Spendebedingungen,** die **Hinweise für Blutspender/innen** und die **Aufklärung über Infektionskrankheiten** zu lesen.
Anschließend lesen Sie bitte den **Fragebogen** aufmerksam durch und kreuzen Zutreffendes an. Bei Fragen und Unklarheiten wenden Sie sich bitte während den Voruntersuchungen an das Pflegepersonal oder den Spendearzt. Sie haben jederzeit die Möglichkeit ohne Angabe von Gründen von der Spende Abstand zu nehmen. Außerdem haben Sie die Möglichkeit, über die Verwendung Ihrer Blutspende zu entscheiden, indem Sie uns vertraulich darauf hinweisen, Ihre Blutspende nicht zur Transfusion an Patienten zu gebrauchen. Dazu erhalten Sie im Spenderaum den Bogen **Entscheidung über die Verwendung Ihres Blutes,** den Sie bitte ankreuzen und in die Wahlbox werfen.

0693-001

Spendebedingungen

Um körperliche Schäden zu vermeiden, dürfen Blutspender **nur bei einer Blutspendeeinrichtung** spenden. Die Blutspendezentrale ist verpflichtet, bei jeder Spende die Identität des Spenders zu überprüfen. Halten Sie daher bitte Ihren **Personalausweis** bereit. Einen Wohnungswechsel sollten Sie der Blutspendezentrale unbedingt mitteilen.
Bei Krankheit des Spenders kann er selbst und insbesondere der Empfänger Schaden an Gesundheit und Leben erleiden. Der Spender ist daher verpflichtet, **bei Auftreten oder Verdacht von Krankheiten** (insbesondere Infektionskrankheiten, Gelbsucht, Tuberkulose, AIDS, Geschlechtskrankheiten) bei sich oder in seiner näheren persönlichen Umgebung **vor jeder Blutspende Mitteilung zu machen.** Wenn bis zu 10 Tage nach einer Blutspende fieberhafte Erkrankungen auftreten, müssen diese ebenfalls gemeldet werden. Nach Aufenthalt in **Gebieten** mit **Malariarisiko** darf 6 Monate lang **kein Blut gespendet werden.**
Es darf am Spendetag und am Vorabend kein Alkohol zu sich genommen werden. Die Einnahme von Medikamenten ist mitzuteilen. **Alkohol-, Medikamenten- und Drogenabhängige dürfen kein Blut spenden.** Bei notwendigen Kontrolluntersuchungen sollen Blutspender kurzfristig zur Verfügung stehen können.
Sollten Gründe vorliegen, die eine Blutspende am heutigen Tag verhindern, wird der Blutspender **zeitlich begrenzt zurückgestellt.** Bei schwerwiegenden Rückstellungsgründen muss der **dauerhafte Ausschluss** von der Spende erfolgen. Im Falle eines Schadens infolge wissentlichem Verschweigen oder vorsätzlicher Falschauskunft kann dies zu Haftungsansprüchen gegenüber dem Spender führen. Die Spendeerklärung ist ein Dokument, das der Aufbewahrungspflicht unterliegt und das Sie sorgfältig ausfüllen müssen bzw. die Richtigkeit Ihrer Angaben mit Ihrer Unterschrift bestätigen.
Sie müssen deshalb ein **ausreichendes Sprachverständnis in Wort und Schrift** haben.
Die Blutspendezentrale haftet ausschließlich für Schäden, die ihre Mitarbeiter schuldhaft oder grob fahrlässig verursachen. Sollten Schäden im Zusammenhang mit der Blutspende entstehen, melden Sie sich bitte unverzüglich in der Blutspendezentrale (Tel. 0211/81-18575).

Bitte lesen Sie auf der nächsten Seite die **Hinweise für Blutspender** ➡

Hausanschrift: Universitätsklinikum Düsseldorf, Moorenstraße 5, 40225 Düsseldorf, Telefon: (02 11) 81 -18575, Telefax: (0211) 81 - 19645
Öffentliche Verkehrsmittel - Straßenbahn: 701, 706, 707, 711, 713, 716; Bus: SB50, 723, 735, 780, 782, 785, 809, 827, 835 und 836

0693-12-10T-BT-I

Blutspendezentrale des Universitätsklinikums Düsseldorf

Hinweise für Blutspender / -innen

Jeder gesunde Mensch zwischen 18 und 68 Jahren kann Blut spenden!

- **Vor der Blutspende** sollten Sie normal, nicht zu fettreich gegessen haben.
- **Bitte spenden Sie nicht mit eingeschränkter Leistungsfähigkeit oder Kreislaufschwäche.**
- Meiden Sie **Alkohol und Nikotin vor und nach** der Blutspende.

Während der Blutspende werden Ihnen aus einer Vene der Armbeuge 500ml Blut innerhalb von 5-15 Minuten entnommen. Anschließend drücken Sie zur Blutstillung ca. 5 Minuten auf den Tupfer über die Punktionsstelle. Bei Wohlbefinden und **nach Rücksprache mit dem Blutspendepersonal** begeben Sie sich zur **Entscheidung über die Verwendung Ihres Blutes.** Anschließend können Sie sich im Warteraum erholen und etwas trinken.
Nach der Blutspende treten in der Regel keine spürbaren Störungen des körperlichen Befinden auf. In 1 bis 3% der Fälle kann es zu **Kreislaufreaktionen** kommen (z.B. Blässe, Schwindel, Übelkeit), in weniger als 1% zu ausgeprägten Störungen wie Kollaps, kurzfristiger Bewusstlosigkeit und Herzrhythmusstörungen **oder Krampfanfall.** Noch seltener sind **Nachblutungen, Schädigungen von Blutgefäßen und / oder Nerven oder Entzündungen** durch die Punktion. Höchst selten sind Nerven- und Gefäßschäden, die von kurzzeitigen Schmerzen, kurzfristiger Lähmung, Taubheitsgefühl, großen Hämatomen bis hin zu irreversiblen Schäden, wie chronischen unbeherrschbaren Schmerzen, Lähmung, Gefäßveränderungen reichen können, die die Lebensführungen beeinflussen können und möglicherweise weitere medizinische Maßnahmen nach sich ziehen. Der Blutverlust wird normalerweise innerhalb weniger Wochen ausgeglichen. Veränderungen des Blutes mit Blutarmut (Anämie, Eisenmangel) sowie nicht normale Anzahl der weißen Blutkörperchen oder Blutplättchen sind selten. Ernährungshinweise zum Ausgleich des Eisenverlustes erhalten Sie in der Spenderannahme.
Kreislaufreaktionen können zu schweren Stürzen und Verletzungen führen. Bitte achten Sie daher unbedingt auf die Anordnungen unseres Blutspendepersonals! Warten Sie mindestens **30 Minuten nach der Spende, bevor Sie die Blutspendezentrale verlassen und 12 Stunden,** bevor Sie eine Tätigkeit ausüben, bei der Sie durch einen Schwächeanfall sich und andere gefährden können. Von **schwerer körperlichen Belastungen in den ersten 24 Stunden** nach der Blutspende wird abgeraten.
Zwischen zwei Blutspenden liegen bei **Frauen mindestens 12 Wochen, bei Männern mindestens 8 Wochen.**
In einzelnen Fällen werden Blut- und Blutbestandteile von Spendern für Qualitätskontrollen, Standardisierungszwecke, Forschungs- und Entwicklungsvorhaben unseres Klinikums verwendet. Alle Blutbestandteile werden grundsätzlich anonymisiert abgegeben. Eine Rückverfolgung der Ereignisse ist nur der Ärztlichen Leitung der Blutspendezentrale vorbehalten.
Bei der vierten Blutspende bekommen Sie einen **Blutspendeausweis,** den Sie zu jeder weiteren Spende mitbringen sollten.

Aufklärung über Infektionskrankheiten

Das durch HIV-Infektion erworbene Immundefekt-Syndrom **(AIDS),** die infektiöse Gelbsucht **(Hepatitis B und C)** und **Syphilis** (Lues) werden durch Kontakt mit Körperflüssigkeit (Blut, Speichel, Samenflüssigkeit) übertragen.
Um eine Ansteckung durch Bluttransfusionen zu vermeiden, sind insbesondere Sicherheitsmaßnahmen notwendig.
Dazu bitten wir Sie um Ihre Mithilfe. Zwar wird jede Blutspende auf die genannten Infektionen untersucht, doch vergehen zwischen Infektion und Nachweisbarkeit einige Wochen.
In den folgenden Personengruppen ist die Häufigkeit von HIV- und Hepatitis-Infektionen deutlich erhöht:

- Drogenkonsumenten
- Männliche und weibliche Prostituierte, Sextouristen/-innen
- Homo- und bisexuelle Männer
- Personen mit häufig wechselnden Intimpartnern
- Häftlinge
- Personen aus Regionen mit hohem Vorkommen von HIV oder Hepatitis (Afrika, Südostasien, ggf. bitte nachfragen)
- Personen, bei denen jemals eine Infektion der genannten Viren festgestellt wurde.

Personen, die einen dieser Gruppen angehören, **dürfen nicht Blut spenden!** Personen mit sexuellem Kontakt zu Angehörigen dieser Gruppen dürfen im Anschluss daran 4 Monate kein Blut spenden.

Lesen Sie nun den **Fragebogen** aufmerksam durch und kreuzen Sie Zutreffendes an. Bei Unklarheiten und Fragen wenden Sie sich bitte jederzeit an die Mitarbeiter der Blutspendezentrale oder im vertraulichen Gespräch an den Spendearzt.
Im Spenderraum erhalten Sie den Bogen **Entscheidung über die Verwendung Ihres Blutes (Fragebogen in rosa)** für den vertraulichen Selbstausschluss. Bitte lesen Sie diesen durch, markieren Sie das entsprechende Feld deutlich und stecken Sie den Bogen in die bereitstehende Wahlbox.
Falls Sie weitere Fragen haben, stehen wir Ihnen gerne zur Verfügung.

Wir danken Ihnen im Namen unserer Patienten für Ihre Bereitschaft, Blut zu spenden.

Und wir freuen uns, wenn Sie wieder kommen! **Ihr Blutspendeteam**

Gültig nach SOP B-Dok 02 V 08

Blutspendezentrale des Universitätsklinikums Düsseldorf

Fragebogen (bitte Zutreffendes ankreuzen)

Name, Vorname	Geburtsdatum
Adresse (PLZ, Straße, Hausnummer)	Tel. privat
Hausarzt	Tel. dienstlich

	Fragen zu Ihrem allgemeinen Gesundheitszustand	
1.	Fühlen Sie sich **krank** oder sind Sie **krankgeschrieben?**	☐ ja ☐ nein
2.	Haben oder hatten Sie eine oder mehrere der folgenden Erkrankungen (ggf. unterstreichen):	
	● Herz-, Gefäß- oder Kreislauferkrankung (z.B. Bluthochdruck, Thrombose, Embolie, Schlaganfall);	☐ ja ☐ nein
	● Erkrankung von Haut, Blut, Gehirn, Nerven- oder Lymphsystem, Lunge (z.B. Asthma), Leber, Niere, Magen oder Darm;	☐ ja ☐ nein
	● Allergie, Autoimmunerkrankung, Rheumatisches Fieber, Epilepsie, Zuckerkrankheit, Tumor (z.B. Krebs)?	☐ ja ☐ nein
3.	Hatten Sie in der letzten Woche	
	● einen unkomplizierten Infekt (z.B. Schnupfen, Erkältung, Harnwegsinfekt),	☐ ja ☐ nein
	● eine zahnärztliche Behandlung	☐ ja ☐ nein
	● eine Verletzung oder einen kleinen operativen Eingriff?	☐ ja ☐ nein
4.	Hatten Sie in den letzten 4 Wochen Durchfall, anhaltende Bauchschmerzen, Erbrechen, eine Entzündung oder Fieber?	☐ ja ☐ nein
5.	Waren Sie in den letzten 4 Monaten in med. Behandlung (im Krankenhaus, beim Arzt, beim Heilpraktiker oder sonstiger Behandlung?	☐ ja ☐ nein
6.	● Ist Ihnen jemals gesagt worden, dass Sie kein Blut spenden dürfen oder sind Sie als Blutspender schon einmal zurückgestellt worden?	☐ ja ☐ nein
	● Hat es bei einer früheren Blutentnahme / Blutspende Komplikationen gegeben?	☐ ja ☐ nein
	● Spenden Sie auch in anderen Einrichtungen?	☐ ja ☐ nein
7.	● Sind Sie alkoholkrank?	☐ ja ☐ nein
	● Sind Sie medikamenten- oder rauschgiftabhängig?	☐ ja ☐ nein
8.	Üben Sie in den nächsten 12 Stunden Tätigkeiten in Beruf oder Hobby aus, die Sie oder andere gefährden können (z.B. Personenbeförderung, Tätigkeit mit Absturzgefahr oder erheblicher körperlicher Belastung)?	☐ ja ☐ nein
9.	**Nur für Frauen:**	
	● Waren Sie jemals schwanger (auch Fehlgeburt, Schwangerschaftsabbruch)?	☐ ja ☐ nein
	● Waren Sie innerhalb der letzten 2 Jahre schwanger?	☐ ja ☐ nein
	● Sind Sie aktuell schwanger oder stillen Sie?	☐ ja ☐ nein
	Fragen zu Infektionskrankheiten, die durch Blut übertragen werden können	
10.	Wurde bei Ihnen jemals	
	● eine Leberentzündung (z.B. Gelbsucht, Hepatitis A, Hepatits B, Hepatits C) festgestellt?	☐ ja ☐ nein
	● eine Infektion mit dem Immunschwächevirus (HIV-1/2: AIDS) oder HTL-Virus (HTL-1/2) nachgewiesen?	☐ ja ☐ nein
11.	● Wurden Sie in den letzten 4 Monaten akupunktiert?	☐ ja ☐ nein
	● Haben Sie sich in den letzten 4 Monaten einer hautverletzenden Maßnahme unterzogen, wie Tätowierung, Piercing, Ohrlochstechen oder kosmetische Behandlung (z.B. Botox-spritzen, permanentes Make-up)?	☐ ja ☐ nein
12.	Haben Sie in den letzten 4 Monaten mit einer Person in einem Haushalt gelebt, bei der eine Leberentzündung (z.B. Gelbsucht, Hepatitis A, Hepatitis B, Hepatitis C) festgestellt wurde?	☐ ja ☐ nein
13.	Sind Sie in den letzten 4 Monaten in Berührung mit Blut einer anderen Person gekommen, z.B. über die Schleimhaut (auch Auge) oder durch Verletzung mit einem Instrument (z.B. Injektionsnadel)?	☐ ja ☐ nein
14.	● Haben Sie innerhalb der letzten 2 Jahre eine Blutübertragung (rote Blutkörperchen, Blutplättchen, Blutplasma), auch Eigenblut erhalten?	☐ ja ☐ nein
	● Erhielten Sie in den letzten 4 Monaten Medikamente aus Blutplasma, wie Blutgerinnungsfaktoren oder Immunglobuline (z.B. Antikörper gegen Tetanus)?	☐ ja ☐ nein
15.	Hatten Sie in den letzten 4 Monaten eine Operation, eine Gewebetransplantation, eine Endoskopie (z.B. Magen-, Blasen-, Darm- oder Gelenkspiegelung), eine Katheteranwendung oder wurde Ihnen Gewebe entnommen (Biopsie)?	☐ ja ☐ nein
16.	● Hatten Sie in den letzten 4 Monaten ungeschützten Intimkontakt (vaginal, oral oder anal ohne Kondom) mit einer neuen Partnerin / einem neuen Partner?	☐ ja ☐ nein
	● **Für Männer:** Hatten Sie schon einmal Intimkontakt mit einem anderen Mann?	☐ ja ☐ nein
17.	Hatten Sie in den letzten 4 Monaten Intimkontakt,	
	● mit einer Person, die mehr als 6 Monate außerhalb Europas gelebt hat?	☐ ja ☐ nein
	● mit einer Person, die eine schwere Infektionskrankheit (AIDS oder Hepatitis) übertragen könnte?	☐ ja ☐ nein
	● für den Sie Geld oder andere Leistungen (Unterkunft, Drogen) bezahlt haben?	☐ ja ☐ nein
	● **Für Frauen:** Hatten Sie in den letzten 4 Monaten Intimkontakt mit einem bisexuellen Mann?	☐ ja ☐ nein
18.	● Haben Sie jemals für Intimkontakt Geld oder andere Leistungen (Unterkunft, Drogen) erhalten?	☐ ja ☐ nein
	● Haben Sie jemals Drogen gespritzt oder geschnupft?	☐ ja ☐ nein
	● Waren Sie innerhalb der letzten 4 Monate in Haft?	☐ ja ☐ nein
19.	Haben Sie in den letzten 4 Monaten Spritzen erhalten, die nicht vom Arzt verschrieben wurden (z.B. Muskelaufbaupräparate)?	☐ ja ☐ nein
20.	● Haben Sie jemals Frischzellen bzw. Gewebe (Transplantate) von Tieren erhalten?	☐ ja ☐ nein
	● Sind Sie in den letzten 12 Monaten nach einem Tierkontakt gegen Tollwut geimpft worden?	☐ ja ☐ nein
	● Erhielten Sie in den letzten 12 Monaten tierisches Serum (z.B. gegen Schlangenbisse)?	☐ ja ☐ nein

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Weitere Fragen siehe Rückseite

Blutspendezentrale des Universitätsklinikums Düsseldorf

21.	● Sind Sie außerhalb Europas geboren?	☐ ja ☐ nein
	● Haben Sie jemals länger als 6 Monate außerhalb Europas gelebt? Wenn ja, wo?_____ wann?_____	☐ ja ☐ nein
	● Waren Sie in den letzten 6 Monaten, auch kurzfristig, im Ausland? Wenn ja, wo?_____ wann?_____	☐ ja ☐ nein
22.	Wurde bei Ihnen jemals eine Malaria festgestellt?	☐ ja ☐ nein
23.	Haben oder hatten Sie eine Syphilis?	☐ ja ☐ nein
24.	Haben oder hatten Sie eine Tuberkulose, Osteomyelitis, Toxoplasmose, Salmonelleninfektion (Typhus- oder Paratyphus), Q-Fieber?	☐ ja ☐ nein
25.	Wurde bei Ihnen jemals eine der folgenden seltenen Erkrankungen festgestellt: Chagas-Krankheit (Trypanosomiasis), Brucellose, Babesiose, Lèishmaniose, Lepra, Melioidose, Rückfallfieber, Hasenpest (Tularämie), Fleckfieber oder andere Rickettsiosen?	☐ ja ☐ nein
	Fragen zu möglichen Rückständen von Arzneimitteln im Blut	
26.	Haben Sie innerhalb der letzten 4 Wochen Medikamente eingenommen, wie z.B. Antibiotika, Schmerzmittel (auch Aspirin, ASS), Mittel gegen Bluthochdruck oder andere? Wenn ja, welche:_____ Wann letzte Anwendung?_____	☐ ja ☐ nein
27.	Haben Sie jemals Tabletten zur Behandlung von Schuppenflechte oder schwerer Akne eingenommen (z.B. Tigason®, Neo-Tigason®, Roaccutane®)?	☐ ja ☐ nein
28.	Wurden Sie in den letzten 4 Wochen geimpft? Wenn ja, welche Impfungen bzw. wogegen:_____ Wann:_____	☐ ja ☐ nein
	Fragen nach übertragbaren Hirnerkrankungen	
29.	Wurde bei Ihnen oder einem Ihrer Blutsverwandten die Creutzfeldt-Jakob-Krankheit (CJK) oder die Variante Creutzfeldt-Jakob-Krankheit (vCJK) festgestellt oder bestand jemals ein Verdacht auf eine dieser Erkrankungen?	☐ ja ☐ nein
30.	● Sind Sie jemals mit Hormonen der Hirnanhangdrüse, z.B. wegen Wachstumsstörungen, Unfruchtbarkeit, Endometriose behandelt worden?	☐ ja ☐ nein
	● Haben Sie jemals Hornhaut- (Cornea), Hirnhaut- (Dura mater) oder andere Transplantate erhalten?	☐ ja ☐ nein
31.	● Haben Sie sich vom 01.01.1980 bis 31.12.1996 insgesamt länger als 6 Monate im Vereinigten Königreich Großbritannien und Nordirland aufgehalten?	☐ ja ☐ nein
	● Wurden Sie im Vereinigten Königreich Großbritannien und Nordirland nach dem 01.01.1980 operiert oder haben Sie dort eine Blutübertragung (rote Blutkörperchen, Blutplättchen, Blutplasma) erhalten?	☐ ja ☐ nein

Hiermit erkläre ich durch Unterschrift, dass ich alle Fragen verstanden, alle Angaben nach bestem Wissen und Gewissen gemacht habe und mit der Speicherung meiner blutspenderrelevanten Daten, unter Berücksichtigung des Datenschutzes, einverstanden bin. Mir ist bewusst, dass unvollständige oder falsche Angaben unter Umständen schwere gesundheitliche Risiken oder den Tod für die Empfänger meines Blutes bedeuten können und dass ich für den Schaden, der durch vorsätzliches oder fahrlässiges Verschweigen entsteht, verantwortlich bin. Bei Blutspende trotz Drogenkonsum können Schadensersatzansprüche gegen mich geltend gemacht werden.
Sollte ich irgendwelche Zweifel an meiner Eignung zum Blutspenden haben oder bekommen, werde ich mich unverzüglich vertraulich (z.B. auch telefonisch) an eine/n Ärztin/Arzt des Blutspendedienstes wenden. Ebenso werde ich mich im Falle einer in den nächsten Monaten auftretenden Erkrankung bzw. Infektion sofort beim Blutspendedienst melden. Über die Risiken bei der Blutspende bin ich in einem ausführlichen Gespräch durch eine/n Ärztin/Arzt aufgeklärt worden. Ich hatte ausreichend Gelegenheit, Fragen zu stellen und habe diese zufriedenstellend beantwortet bekommen.
Die Spenderbedingungen, die Hinweise für Blutspender und die Aufklärung über Infektionskrankheiten habe ich gelesen und verstanden.
Ich bin einverstanden mit einer Blutspende sowie den notwendigen Untersuchungen meines Blutes einschließlich eines HIV-Tests. Ich bin damit einverstanden, dass das Blutspendezentrum des Universitätsklinikums Düsseldorf über meine Blutspende verfügen darf.
Ich bin einverstanden, dass in einzelnen Fällen Blut/Blutbestandteile für Qualitätskontrollen, Standardisierungszwecke, Forschungs- und Entwicklungsvorhaben unseres Klinikums verwendet werden können. Ich weiß, dass ich Fragen mit dem Spendearzt vertraulich besprechen kann.

Datum: _____ **Unterschrift:** _____

RR_____ / _____ mm Hg
Puls_____ / min.
Hb_____ g / dl
Temp._____ °C
Größe_____ cm Abz.
Gewicht_____ kg

Anmerkungen: _____

Nur vom Arzt ausfüllen:

Spendefähig: ☐ ja ☐ z.Zt. nicht ☐ Dauersperre

Ggf. Untersuchungsbefund (z.B. Neuspender)

Rückstellungsgrund: _____

Unterschrift Ärztin / Arzt _____

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