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Antenatal and Pre- conceptional Carrier Screening of Thalassemia in Obs & Gynae OPD, BSMMU

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Abstract

Background: *Thalassemia remains a major health burden in regions without screening programs. This study aims to propose a simple, cost-effective screening method using complete blood count.*

Aim of the study: *The aim of the study was to determine the prevalence of thalassemia carrier status among pregnant women and those planning for pregnancy attending the Obstetrics & Gynecology out-patient department at BSMMU.*

Methods: *This cross-sectional study was conducted at the OPD of Obstetrics and Gynecology, BSMMU, Dhaka, from July 2016 to June 2017. It included 292 women (pregnant or planning pregnancy) visiting for antenatal or pre-conception care. Data were collected via case record forms, interviews, and blood samples for hematological testing. Data were analyzed using SPSS (frequencies, percentages, regression; $p \leq 0.05$ significant).*

Results: *The study population (N=292) had a mean age of 28.91 ± 8.81 years, with most participants (39.0%) aged 25-36 years. Most were housewives (63.7%) and lived in urban areas (67.5%). In terms of thalassemia traits, 65.1% were normal, 19.2% had Hb E trait, and 7.5% had Beta trait. Hemoglobin, MCV, and MCH levels were highest in the normal group and lowest in the Hb E Disease (HbEE) group. Other hemoglobinopathies like Hb E Disease, Low Hb A2, and Persistent Fetal Hemoglobin were less common.*

Conclusion: *This study highlights the high prevalence of thalassemia traits among women at BSMMU, emphasizing the need for antenatal and pre-conception screening to enable early detection, genetic counseling, and informed reproductive choices, reducing thalassemia's burden.*

Keywords: *Thalassemia, Screening, Hemoglobinopathy, Complete Blood Count, Prenatal Diagnosis.*

1. INTRODUCTION

Thalassemia, the most common hereditary anemia, is characterized by defects in the synthesis of one or more globin chains that form the hemoglobin (Hb) tetramer. β-thalassemia, one of the genetic hemoglobinopathies inherited in an autosomal recessive pattern, is known to be caused by more than 200 point mutations at the molecular level.[1] Thalassemia, along with other hemoglobinopathies, is the most prevalent genetic disorder, affecting approximately 7% of the global population.[2]

According to the Thalassemia International Federation, only about 200,000 patients with thalassemia major are currently alive and registered as receiving regular treatment worldwide.[3] The condition has a high prevalence in the Mediterranean countries, the

Middle East, Central Asia, India, southern China, the Far East, as well as countries along the northern coast of Africa and in South America.[4] β-thalassemia is one of the most common inherited hemoglobin disorders, and its statistics in Pakistan present a grim scenario. It has an overall carrier frequency of more than 5%.[5] Approximately 40,000 transfusion-dependent children with thalassemia major are currently registered, and nearly 5,250 new cases are born each year in a population of about 150 million.[6] β-thalassemia is among the most common inherited hemoglobin disorders, and its statistics present a grim scenario. Homozygous β-thalassemia patients typically present with severe anemia within the first year of life. Severe anemia is incompatible with life; therefore, patients require regular blood transfusions and iron chelation therapy for survival.[7] However, the cost of treatment is often unaffordable for the average family, creating a significant financial burden on both the family and society.[4] The most effective strategy is to identify carriers through screening, provide genetic counseling, and offer prenatal diagnosis to reduce the birth rate of affected infants and improve the prognosis of those affected.[8] Countries such as Cyprus, Italy, and Greece have well-established screening and prenatal diagnostic programs, achieving 100% success in reducing the birth prevalence of homozygous β-thalassemia to zero.[9,10,11] Globally, screening and prevention programs utilize methods such as pre-pregnancy and pregnancy screening (including chorionic villus sampling during the first trimester). The aim of these approaches is to reduce the birth rate of affected infants. Bangladesh currently lacks a national thalassemia screening or prevention program or any related policy.

Structural hemoglobinopathies significantly influence red blood cell indices, which play a crucial role in diagnosing thalassemias. Key components of the complete blood count (CBC) include hemoglobin (Hb), red blood cell (RBC) count, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and red cell distribution width (RDW).

Thalassemias are typically characterized as hypochromic, microcytic anemias; hence, MCV and MCH are critical diagnostic indicators. Thalassemic individuals generally exhibit reduced MCV and MCH, with a relatively high RBC count. Studies suggest that, for individuals of Indian origin, an MCV of less than 77 fL and MCH less than 27 pg are highly sensitive and specific for the presumptive diagnosis of thalassemia syndromes. [12] RDW reflects the variation in red cell size, and while iron deficiency anemia is often associated with elevated RDW, thalassemias typically result in uniformly microcytic red cells without significant RDW elevation. Thus, RDW may serve as an adjunct but not a standalone diagnostic indicator.

Several indices utilizing CBC components have been developed to differentiate iron deficiency from thalassemia minor reliably; however, none are universally applicable, and none surpass the value of MCV alone in selecting cases for further investigation. [12] Therefore, it is recommended that all pregnant women from ethnic backgrounds at increased risk of hemoglobinopathy and/or thalassemia be screened using both CBC (to assess MCV and MCH) and hemoglobin electrophoresis or HPLC. The present study was conducted to establish a cost-effective, practical method suitable for nationwide implementation, focusing on screening pregnant women and pre-conceptional cases using a simple complete blood count.

2. Objective

- The aim of the study was to determine the prevalence of thalassemia carrier status among pregnant women and those planning for pregnancy attending the Obstetrics & Gynecology out-patient department at BSMMU.

3. Methodology & Materials

This cross-sectional observational study was conducted at the Outpatient Department (OPD) of Obstetrics and Gynecology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, between July 2016 and June 2017. The study included women of childbearing age, specifically pregnant women and those planning for pregnancy, who visited the OPD for antenatal checkups or pre-conception counseling. A total of **292 participants** were recruited.

Inclusion Criteria

- Adult women planning for pregnancy visiting the OPD of Obstetrics and Gynecology at BSMMU.
- Pregnant women visiting the OPD for antenatal checkups.

Exclusion Criteria

- Women with established thalassemia major or other causes of anemia (e.g., iron deficiency, chronic disease, hemorrhage).

- Women with acute illnesses such as pre-eclampsia, eclampsia, or sepsis.
- Women diagnosed with major psychosocial diseases.
- Unwilling or non-consenting women.

Data were collected using a pre-designed, pre-tested case record form (CRF) and laboratory checklists. Trained research physicians conducted face-to-face interviews to gather socio-demographic, clinical, and anthropometric data. Venous blood samples (3 mL) were collected under aseptic conditions for hematological testing, supervised by a hematologist. Screening included evaluation of red blood cell indices (MCV, MCH), with thalassemia confirmed via Hb Electrophoresis or High-Performance Liquid Chromatography (HPLC); DNA testing was used for mutation detection where necessary. Data were analyzed using SPSS version 22.0, with results expressed as frequencies, percentages, and multivariate regression ($p \leq 0.05$ considered significant). Quality assurance measures included pilot testing, supervisor oversight, and laboratory quality control using standard and control samples. Ethical compliance was ensured through informed written consent, confidentiality, and the right of participants to withdraw at any time without affecting their medical care.

4. RESULTS

Table 1. *Socio-Demographic Characteristics of Study Population (N=292)*

Characteristics		Frequency	Percentage
Age (In Years)	12-24	104	35.6%
	25 - 36	114	39.0%
	37 - 48	74	25.3%
	Mean±SD	28.91±8.81	
Education	Illiterate	58	19.9%
	Primary	56	19.2%
	SSC	68	23.3%
	HSC	62	21.2%
	Graduate or Above	48	16.4%
Occupation	House wife	186	63.7%
	Service	32	11.0%
	Student	72	24.7%
	Skilled Laborer	2	0.7%
Residence	Urban	197	67.5%
	Rural	95	32.5%

Table 1 shows the socio-demographic characteristics of the study population. The majority of participants were aged between 25 and 36 years, with 114 (39.0%) individuals falling into this age group. In terms of education, 68 (23.3%) participants had completed their Secondary School Certificate (SSC), and 186 (63.7%) participants were housewives. Regarding residence, 197 (67.5%) participants lived in urban areas, while 95 (32.5%) were from rural areas.

Table 2. *Age Distribution in Normal & Thalassemia Trait/Hemoglobinopathy Group (N=292)*

Age Group (N=292)	Normal (N=190)	Hb E Trait (N=56)	Beta Trait (N=22)	HbEE (N=6)	Low Hb A2 (N=16)	Fetal Hemoglobin (N=2)
12–24 Years (N=104)	64 (61.5%)	28 (26.9%)	8 (7.7%)	0	4 (3.8%)	0
25–36 Years (N=114)	76 (66.7%)	16 (14.0%)	8 (7.0%)	6 (5.3%)	8 (7.0%)	0
37–48 Years (N=74)	50 (67.6%)	12 (16.2%)	6 (8.1%)	0	4 (5.4%)	2 (2.7%)

Table 2 shows the distribution of participants by age group across different hemoglobinopathy traits. Among the 104 participants aged 12–24 years, the majority were classified as normal (64, 61.5%), while 28 (26.9%) had Hb E trait. In the 25–36 years age group (N=114), 76 (66.7%) were normal, and 16 (14.0%) had Hb E trait. For the 37–48 years age group (N=74), 50 (67.6%)

were normal, with 12 (16.2%) having Hb E trait. The table also presents the distribution of Beta Trait, HbEE, Low Hb A2, and Fetal Hemoglobin across age groups.

Table 3. *Distribution of Hemoglobin, MCH, and MCV in Different Hemoglobinopathy Groups*

N=292	Normal (Mean±SD)	Beta Trait (Mean±SD)	Hb E Trait (Mean±SD)	Hb E Disease (HbEE) (Mean±SD)	Low Hb A2 Level (Mean±SD)	Persistent Fetal Hemoglobin (Mean±SD)
Hb	10.26 ± 1.80	9.66 ± 1.82	10.15 ± 2.06	8.96 ± 0.58	8.97 ± 2.30	12.30 ± 0.00
MCV ≤ 77	71.45 ± 5.08	64.81 ± 5.40	69.45 ± 6.12	55.64 ± 4.73	65.48 ± 9.04	68.80 ± 0.00
MCH ≤ 27	22.90 ± 2.59	19.44 ± 2.39	21.70 ± 3.47	18.20 ± 1.73	18.83 ± 3.85	22.90 ± 0.00

Table 3 shows the distribution of hemoglobin (Hb), mean corpuscular volume (MCV), and mean corpuscular hemoglobin (MCH) in different hemoglobinopathy groups (N=292). The mean Hb value for the normal group was 10.26 ± 1.80 g/dL, with lower values observed in the Beta trait (9.66 ± 1.82 g/dL) and Hb E trait (10.15 ± 2.06 g/dL) groups, while Hb E Disease (HbEE) had the lowest mean value of 8.96 ± 0.58 g/dL. The normal group showed a higher mean MCV (71.45 ± 5.08 fL) compared to Beta trait (64.81 ± 5.40 fL) and Hb E trait (69.45 ± 6.12 fL), with the lowest MCV in the Hb E Disease group (55.64 ± 4.73 fL). Similarly, the MCH was highest in the normal group (22.90 ± 2.59 pg), and the lowest in Hb E Disease (18.20 ± 1.73 pg). Persistent fetal hemoglobin had normal values for Hb and MCH, with MCV at 68.80 ± 0.00 fL.

Table 4. *Frequency of Thalassemia Trait/Hb E Trait/Hb E Disease in Study Population (N=292)*

N=292	Frequency	Percentage
Normal	190	65.1%
Beta Trait	22	7.5%
Hb E Trait	56	19.2%
Hb E Disease (HbEE)	6	2.1%
Low Hb A2 Level	16	5.5%
Persistent Fetal Hemoglobin	2	0.7%

Table 4 illustrates the frequency and percentage distribution of different thalassemia and hemoglobinopathies in the study population (N=292). The majority of the study population were found to be normal (190 participants, 65.1%). The Hb E trait group represented 19.2% (56 participants), while Beta trait accounted for 7.5% (22 participants). Hb E disease (HbEE) was observed in 6 participants (2.1%), Low Hb A2 Level in 16 participants (5.5%), and persistent fetal hemoglobin was found in 2 participants (0.7%).

5. Discussion

This study highlights the prevalence and hematological characteristics of thalassemia carrier status among women of childbearing age attending a tertiary care hospital in Bangladesh. Thalassemia, a common inherited hemoglobin disorder, poses significant public health concerns, particularly in regions with high carrier rates. The findings underscore the substantial burden of various hemoglobinopathies, such as Hb E trait and β-thalassemia trait, within this population. The association of these conditions with altered hematological parameters emphasizes the importance of early identification and genetic counseling to prevent severe forms of the disease in future generations. Strengthening screening programs and public awareness initiatives is essential to mitigate the long-term impact of thalassemia in Bangladesh.

The socio-demographic characteristics of the study population revealed that the majority of participants were aged 25–36 years (39.0%), followed by the 12–24 years age group (35.6%).

This is consistent with the findings of Palit et al. [13], where the mean age of women screened for thalassemia was 24.1 ± 2.4 years. Al et al.[14] also reported a mean participant age of 26.3 years. Similarly, Pauisri et al.[15] reported that the mean age of participants in their study was 27.4 years (ranging from 16 to 43 years), indicating that thalassemia screening is most relevant for women in their reproductive years. In terms of education, 23.3% of participants had completed their Secondary School Certificate (SSC), while 16.4% were graduates or above, reflecting a diverse educational background. Regarding occupation, 63.7% were housewives,

which aligns with the socio-cultural context of the region, where a significant proportion of women in antenatal care are homemakers. Additionally, 67.5% of participants resided in urban areas, likely due to better access to healthcare facilities compared to rural areas. These findings underscore the importance of targeted screening programs, particularly for women in urban settings and those with limited education, to improve thalassemia awareness and promote early detection.

The distribution of thalassemia traits across age groups in this study revealed that Hb E trait was most prevalent in the 12–24 years age group (26.9%), while Beta trait was relatively evenly distributed across all age groups (7.7% in 12–24 years, 7.0% in 25–36 years, and 8.1% in 37–48 years). These findings align with previous studies, such as Saxena et al.[16], which also reported a higher prevalence of thalassemia traits in younger women of reproductive age. The low MCV and MCH values observed in thalassemia trait groups (e.g., Beta trait: MCV = 64.81 ± 5.40 fL, MCH = 19.44 ± 2.39 pg) are consistent with findings from other studies, where 90.9% of thalassemia minor-positive females had MCV < 77 fL and 100% had MCH < 27 pg. The use of Hb Electrophoresis/HPLC in this study to confirm thalassemia traits is also supported by findings from other studies, where HbA2 ≥ 3.5 was a key diagnostic marker for Beta thalassemia trait.[16] These similarities highlight the reliability of using MCV, MCH, and HbA2 levels as diagnostic tools for thalassemia screening in antenatal and pre-conceptional care at BSMMU.

The distribution of hematological parameters in this study revealed that Hb levels were significantly lower in thalassemia trait groups (e.g., Beta trait: 9.66 ± 1.82 g/dL, Hb E trait: 10.15 ± 2.06 g/dL) compared to the normal group (10.26 ± 1.80 g/dL). These findings align with the other study, which reported a mean hemoglobin value of 9.74 ± 1.16 g/dL in thalassemia carriers, further confirming the association between thalassemia traits and reduced hemoglobin levels. Similarly, the low MCV and MCH values observed in thalassemia trait groups (e.g., Beta trait: MCV = 64.81 ± 5.40 fL, MCH = 19.44 ± 2.39 pg; Hb E trait: MCV = 69.45 ± 6.12 fL, MCH = 21.70 ± 3.47 pg) are consistent with findings from Chakraborty et al.[17], Piplani et al.[18], and Madan et al.[19], who reported similar MCV and MCH values in thalassemia carriers. Similarly, the low MCV and MCH values observed in thalassemia trait groups (e.g., Beta trait: MCV = 64.81 ± 5.40 fL, MCH = 19.44 ± 2.39 pg; Hb E trait: MCV = 69.45 ± 6.12 fL, MCH = 21.70 ± 3.47 pg) are consistent with their findings, where 58.15% of patients had microcytic hypochromic indices (MCV < 77 fL, MCH < 27 pg). However, the prevalence of Hb E trait (19.2%) in this study was notably higher than in their study (0.05%), which may reflect regional differences in hemoglobinopathy distribution. These findings highlight the critical role of MCV, MCH, and Hb levels in thalassemia screening, serving as a cornerstone for early detection and intervention in antenatal and pre-conceptional care, ultimately paving the way for healthier futures.

The frequency distribution of thalassemia traits and hemoglobinopathies in this study demonstrated that the majority of participants were normal (65.1%), with Hb E trait emerging as the most prevalent abnormality (19.2%), followed by β-thalassemia trait (7.5%) and Hb E disease (2.1%). The notable prevalence of Hb E trait underscores its prominence as a significant hemoglobinopathy within this population, warranting focused screening and awareness initiatives. Furthermore, the detection of conditions such as low Hb A2 levels (5.5%) and persistent fetal hemoglobin (0.7%) reflects the heterogeneity of hemoglobinopathies present in this cohort. These findings highlight the critical role of routine antenatal and pre-conception carrier screening in identifying at-risk individuals, facilitating timely genetic counseling, and ultimately mitigating the risk of severe thalassemia in offspring. Incorporating these insights into national screening policies can significantly contribute to reducing the long-term burden of thalassemia and improving maternal and child health outcomes.

6. Limitations of the Study

This study had some limitations:

- The study was conducted in a selected tertiary-level hospital.
- The sample was not randomly selected.
- The study's limited geographic scope may introduce sample bias, potentially affecting the broader applicability of the findings.

7. Conclusion

This study aimed to determine the prevalence of thalassemia carrier status among pregnant women and those planning for pregnancy at BSMMU. The findings revealed that a significant proportion of the study population were carriers

of thalassemia traits or hemoglobinopathies, with Hb E trait being the most common. Most participants were young women, primarily housewives from urban areas. Hematological parameters such as hemoglobin, MCV, and MCH were notably lower in thalassemia carriers compared to the normal group. These results emphasize the importance of antenatal and pre-conception carrier screening for thalassemia to enable early detection, genetic counseling, and informed reproductive choices. Implementing routine screening programs and raising awareness can help reduce the burden of thalassemia and improve maternal and child health outcomes.

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