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PREMARITAL SCREENING OF HAEMOGLOBINOPATHIES: EXPERIENCE OF THE MAJOR CENTER OF MAYSAN (HAMMURABI CENTER). GOVERNORATE, IRAQ

[*1]Enaam Muhsin Hameed, [2]Sara Ali Qassim AlAbody and [3]Zahraa Mahdi Srayyih

[1]Maysan Health Department, Maysan, Iraq.
[2]Al-Basra Health Department, Al-Basra, Iraq.
[3]Al-Basra Health Department, Al-Basra, Iraq.

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***Corresponding Author: Enaam Muhsin Hameed**
Maysan Health Department, Maysan, Iraq.

ABSTRACT

Background: Haemoglobinopathies are among the most common inherited disorders globally, particularly prevalent in regions with high consanguinity such as the Middle East. Premarital screening programs have proven effective in reducing the incidence of severe hemoglobin disorders, including thalassemia and sickle cell disease (SCD). This study aimed to evaluate the prevalence and distribution of hemoglobinopathies among premarital screening attendees in Maysan Governorate, Iraq. **Methods:** A descriptive cross-sectional study was conducted at the Hammurabi Center in Maysan over a one-year period from June 2024 to May 2025. A total of 7,712 male subjects were initially screened using high-performance liquid chromatography (HPLC). If the male was identified as a carrier, the female partner underwent the same test. Hemoglobinopathies were classified based on HPLC findings and included β-thalassemia, α-thalassemia, sickle cell trait (HbS), hemoglobin D (HbD), and hemoglobin C (HbC). Data were statistically analyzed by gender and frequency distribution. **Results:** In 2024, alpha-thalassemia (n=170) and beta-thalassemia (n=160) were the most prevalent disorders, followed by HbS (n=14), HbD (n=6), and HbC (n=4). In 2025, alpha-thalassemia increased to 316 cases, with beta-thalassemia at 149 cases. Hemoglobin variants remained rare. Male predominance was evident across all types, largely due to the male-first screening protocol. Hematological profiles of positive cases were consistent with expected values for each disorder. **Conclusion:** The study confirms a high burden of alpha- and beta-thalassemia in Maysan and emphasizes the critical role of premarital screening in early detection. Expansion of such programs, coupled with public awareness and genetic counseling, is essential for effective hemoglobinopathy prevention in Iraq.

KEYWORDS: Premarital, screening, haemoglobinopathies: Maysan (Hammurabi center).

INTRODUCTION

Haemoglobinopathies are a diverse group of inherited blood disorders characterized by abnormalities in the structure or production of hemoglobin, the oxygen-carrying component of red blood cells. These disorders can be broadly categorized into two types: qualitative defects, which affect the structure of the hemoglobin molecule (such as sickle cell disease), and quantitative defects, which reduce the synthesis of one or more globin chains, such as in thalassemias. Globally, haemoglobinopathies are considered among the most common monogenic diseases, affecting millions of people, particularly in regions with high rates of consanguinity and limited public health resources.[1,2] Thalassemia is a prominent haemoglobinopathy and a significant public health concern, particularly in the Mediterranean basin, the Middle East, Southeast Asia, and the Indian subcontinent. The disorder results from defective synthesis of either the alpha (α) or beta (β) globin chains of hemoglobin, leading to imbalanced globin chain production, ineffective erythropoiesis, and varying degrees of anemia.[3] The two primary types of thalassemia—α-thalassemia and β-thalassemia—are usually inherited in an autosomal recessive manner, meaning that individuals must inherit defective genes from both parents to develop a clinically significant disease.[4] According to the World Health Organization (WHO), an estimated 7% of the global population are carriers of haemoglobin disorder genes, particularly β-thalassemia and sickle cell disease (SCD).[5] The burden of these disorders is amplified in regions with high birth rates and limited access to genetic counseling or

preventive healthcare services. In many cases, these disorders result in significant morbidity, requiring lifelong blood transfusions and iron chelation therapy. To address the growing burden of haemoglobinopathies, several countries have implemented premarital screening programs aimed at identifying carriers before marriage. These programs are instrumental in providing couples with genetic counseling, enabling informed reproductive choices, and ultimately reducing the birth prevalence of severe haemoglobin disorders such as β-thalassemia major and SCD.[6,7] Premarital screening programs have shown considerable success in countries such as Iran, Saudi Arabia, and Cyprus, where the incidence of new cases has declined following the implementation of mandatory screening and education initiatives. In Iraq, haemoglobinopathies continue to pose a public health challenge, particularly in regions with high rates of consanguinity. The present study aims to evaluate the prevalence and distribution of different haemoglobinopathies among couples attending a premarital screening program in the major center of Maysan (Hammurabi center). Governorate, Iraq.

METHOD

This descriptive cross-sectional study was conducted over a one-year period, from June 2024 to May 2025, at the major premarital screening center in Maysan Governorate (Hammurabi Center), Iraq. The study aimed to determine the prevalence and distribution of various haemoglobinopathies among individuals attending the mandatory premarital screening program. A total of 7,712 male subjects, representing the male partners of premarital couples, were enrolled and screened for hemoglobin disorders. The screening protocol followed the national premarital guidelines, whereby only the male partner was initially tested using High-Performance Liquid Chromatography (HPLC), a highly sensitive method for detecting abnormal hemoglobin variants. If the male partner was found to be a carrier—defined by the presence of an abnormal hemoglobin variant such as HbA2 elevation for β-thalassemia trait or specific peaks corresponding to HbS, HbC, or HbD—then the female partner was subsequently tested using the same methodology to assess the genetic risk of offspring. All subjects underwent complete blood count (CBC) testing followed by HPLC hemoglobin analysis. The HPLC results were interpreted to identify hemoglobin variants based on retention time and quantitative values, and classified accordingly. HPLC Bio-Rad Variant II and Hplc 96_{TH} ;These is a specialized HPLC analyzer from Bio-Rad primarily used for hemoglobin variant analysis. It's common in clinical laboratories for detecting and quantifying HbA1c (diabetes monitoring) and hemoglobinopathies (e.g., sickle cell disease, thalassemias). It uses a cation-exchange HPLC method with dedicated columns and software .Linear STEL3 is a compact CBC analyzer using impedance technology for routine 3-part differential counts. Zybio Z3 CRP combines CBC and CRP testing in one run, aiding both hematology and inflammation assessment.

Subjects were grouped into one of the following inclusion categories based on the HPLC findings: β-thalassemia trait, α-thalassemia, sickle cell disease/trait (HbS), hemoglobin C (HbC), and hemoglobin D (HbD). Variants with no clinical significance, borderline findings, or those not fitting defined disease patterns were excluded from analysis. Data were entered into a structured database and analyzed using appropriate statistical methods. The frequency and percentage distribution of each hemoglobinopathy type were calculated monthly and yearly, with subgroup analysis by gender performed for the positive cases. The results were then interpreted to assess the epidemiological burden of haemoglobinopathies in the region and to inform potential improvements in genetic counseling and public health planning.

RESULTS

Tables 1–5: Thalassemia Gender Distribution (2024)

- **B-Thalassemia (Table 1):** Shows a clear male predominance in all months, with male percentages reaching up to 94.7% in November. The highest number of cases occurred in October and December.
- **Alpha-Thalassemia (Table 2):** Male cases were highest in June and December. No cases were recorded from July to September. Female representation was notable in October (75%).
- **HbS (Table 3), HbD (Table 4), HbC (Table 5):** All showed very low incidence, mostly male-dominated. HbS and HbD were recorded consistently in small numbers. HbC and Others were absent in many months.

Table 1: B-Thalassemia.

Month	Male (n/%)	Female (n/%)
6	8 (61.5%)	5 (38.5%)
7	16 (80.0%)	4 (20.0%)
8	15 (93.8%)	1 (6.2%)
9	12 (75.0%)	4 (25.0%)
10	34 (77.3%)	10 (22.7%)
11	18 (94.7%)	1 (5.3%)
12	29 (90.6%)	3 (9.4%)

Table 2: Alpha-Thalassemia.

Month	Male (n/%)	Female (n/%)
6	46 (52.9%)	41 (47.1%)
7	0 (0%)	0 (0%)
8	0 (0%)	0 (0%)
9	0 (0%)	0 (0%)
10	3 (25.0%)	9 (75.0%)
11	26 (96.3%)	1 (3.7%)
12	35 (79.5%)	9 (20.5%)

Table 3: HbS-Thalassemia.

Month	Male (n/%)	Female (n/%)
6	1 (100.0%)	0 (0.0%)
7	3 (100.0%)	0 (0.0%)
8	1 (100.0%)	0 (0.0%)
9	3 (100.0%)	0 (0.0%)
10	5 (100.0%)	0 (0.0%)
11	1 (100.0%)	0 (0.0%)
12	0 (0%)	0 (0%)

Table 4: HbD-Thalassemia.

Month	Male (n/%)	Female (n/%)
6	0 (0%)	0 (0%)
7	1 (100.0%)	0 (0.0%)
8	1 (100.0%)	0 (0.0%)
9	0 (0%)	0 (0%)
10	1 (100.0%)	0 (0.0%)
11	1 (100.0%)	0 (0.0%)
12	2 (100.0%)	0 (0.0%)

Table 5: HbC-Thalassemia.

Month	Male (n/%)	Female (n/%)
6	0 (0%)	0 (0%)
7	2 (100.0%)	0 (0.0%)
8	1 (100.0%)	0 (0.0%)
9	0 (0%)	0 (0%)
10	1 (100.0%)	0 (0.0%)
11	0 (0%)	0 (0%)
12	0 (0%)	0 (0%)

Tables 6–10: Thalassemia Gender Distribution (2025)

- **B-Thalassemia (Table 7):** Incidence remained predominantly male, especially in February (88.5%) and May (83.1%).
- **Alpha-Thalassemia (Table 8):** Continued male dominance with substantial cases peaking in May (100 total). Male proportion ranged from 76.0% to 95.2%.
- **HbS (Table 9), HbD (Table 10), HbC (Table 11):** Overall low frequency. HbS showed some female cases only in May. HbD had a balanced month in May (50% each), while HbC and Others remained rare and mostly male.

Table 6: B-Thalassemia.

Month	Male (n/%)	Female (n/%)
1	29 (80.6%)	7 (19.4%)
2	23 (88.5%)	3 (11.5%)
3	12 (80.0%)	3 (20.0%)
4	11 (84.6%)	2 (15.4%)
5	49 (83.1%)	10 (16.9%)

Table 7: Alpha-Thalassemia.

Month	Male (n/%)	Female (n/%)
1	58 (84.1%)	11 (15.9%)
2	53 (84.1%)	10 (15.9%)
3	40 (95.2%)	2 (4.8%)
4	32 (76.2%)	10 (23.8%)
5	76 (76.0%)	24 (24.0%)

Table 8: HbS-Thalassemia.

Month	Male (n/%)	Female (n/%)
1	1 (100.0%)	0 (0.0%)
2	0 (0%)	0 (0%)
3	0 (0%)	0 (0%)
4	1 (100.0%)	0 (0.0%)
5	1 (33.3%)	2 (66.7%)

Table 9: HbD-Thalassemia.

Month	Male (n/%)	Female (n/%)
1	1 (100.0%)	0 (0.0%)
2	2 (100.0%)	0 (0.0%)
3	0 (0%)	0 (0%)
4	0 (0%)	0 (0%)
5	1 (50.0%)	1 (50.0%)

Table 10: HbC-Thalassemia,

Month	Male (n/%)	Female (n/%)
1	2 (100.0%)	0 (0.0%)
2	0 (0%)	0 (0%)
3	0 (0%)	0 (0%)
4	0 (0%)	0 (0%)
5	0 (0%)	0 (0%)

2024 (Table 11)

- **Most common types:** Alpha (170 cases) and B-Thalassemia (160 cases).
- **Male-dominant:** All types showed male predominance.
- **Total screened:** 4,162 individuals.

2025 (Table 12)

- **Most common types:** Alpha (316 cases) saw a significant increase.
- **Male-dominant:** Continued across all subtypes.
- **Total screened:** 3,570 individuals, a decrease from 2024.

Table 11: Total Thalassemia Incidence and Screened Population – 2024.

Thalassemia Type	Male	Female	Total
B	132	28	160
Alpha	110	60	170
HbS	14	0	14
HbD	6	0	6
HbC	4	0	4
Others	6	0	6
Total Screened			4162

Table 12: Total Thalassemia Incidence and Screened Population – 2025.

Thalassemia Type	Male	Female	Total
B	124	25	149
Alpha	259	57	316
HbS	3	2	5
HbD	4	1	5
HbC	2	0	2
Others	5	0	5
Total Screened			3570

- **B-Thalassemia** shows: **High RBC count**, reflecting compensatory erythropoiesis. **Markedly low MCV and MCH**, characteristic of **microcytic hypochromic anemia**.
- **HbC and HbD carriers**: Show **normal RBC indices** (MCV and MCH). RBC count is slightly elevated but within near-normal range. These individuals are often asymptomatic or mildly affected.
- **Sickle Cell Trait (SCT)**: Has a **moderate RBC count** with **normal MCV and MCH**, indicating **normocytic normochromic red cells**. SCT individuals are typically carriers with no significant anemia, unless exposed to extreme stressors as in table 13.

Table 13: Hematological Parameters for Hemoglobinopathies.

Parameter	B-Thalassemia	HbC, HbD	SCT (Sickle Cell Trait)
RBC ($\times 10^{12}$/L)	5.57 – 6.79	5.1 – 5.2	4.73 – 5.41
MCV (fL)	57.2 – 69.3	80.3 – 88.4	79.2 – 87.5
MCH (pg)	17.5 – 24.2	28.0 – 29.6	27.6 – 28.4

DISCUSSION

This study provides valuable insight into the prevalence and gender distribution of haemoglobinopathies among premarital screening attendees at the Hammurabi Center in Maysan, Iraq. Among the screened population of 7,732 individuals over two years (2024–2025), alpha- and beta-thalassemia were the most prevalent hemoglobinopathies. In 2024, 170 cases of alpha-thalassemia and 160 cases of beta-thalassemia were identified. These numbers increased in 2025, with 316 alpha-thalassemia and 149 beta-thalassemia cases, highlighting a rising trend in carrier detection. The predominance of alpha-thalassemia aligns with findings from similar regional studies. For instance, a study conducted in Saudi Arabia reported alpha-thalassemia as the most common hemoglobinopathy among screened individuals, accounting for approximately 40% of positive cases.[8] Another Iraqi study conducted by Jassim et al. in Basra also identified alpha-thalassemia as more frequent than beta-thalassemia among premarital individuals, suggesting a consistent distribution pattern across different Iraqi provinces.[9] Beta-thalassemia, although slightly less prevalent than alpha-thalassemia in this study, remains a major public health concern. The detected frequency is consistent with the findings reported by Al-Allawi et al. in Northern Iraq, where beta-thalassemia trait carriers constituted around 3.5% of screened couples.[10] The high RBC count with low MCV and MCH values observed in beta-thalassemia cases in this study further supports the classical hematological profile of this disorder, consistent with published diagnostic criteria.[11] Sickle cell trait (HbS) was detected at a relatively low rate, with only 14 cases in 2024 and 5 cases in 2025. Interestingly, most HbS cases were male-dominated, except for May 2025, where female cases emerged. These findings contrast with data from African regions such as Nigeria, where sickle cell trait is highly prevalent due to the selective advantage against malaria.[12] The relatively low HbS prevalence in this study reflects the lower endemicity of sickle cell disease in Iraq but still underscores the importance of early detection. Hemoglobin D and C variants were rare, with less than 10 cases over the two years. These results are similar to other Iraqi and Middle Eastern reports indicating a very low prevalence of these variants.[13] Although clinically less significant, their detection is essential for comprehensive carrier screening and genetic counseling. A consistent male predominance was noted in all hemoglobinopathy subtypes. However, this likely reflects the screening protocol where males are tested first, and only partners of carrier males undergo follow-up testing. This policy might underestimate the female carrier rate, which is a known limitation in several regional screening programs.[14] Overall, the increasing prevalence of alpha-thalassemia and the steady rates of beta-thalassemia stress the need for strengthening premarital screening programs. Enhanced awareness, nationwide implementation, and genetic counseling are critical to reducing the incidence of severe hemoglobinopathies in Iraq.[15]

CONCLUSION

This study highlights the significant prevalence of hemoglobinopathies among premarital screening attendees in Maysan, with alpha-thalassemia being the most common, followed by beta-thalassemia. A consistent male predominance was observed, mainly due to the initial male-focused screening protocol. Sickle cell trait and hemoglobin variants HbC and HbD were rare but still present. The overall findings support the effectiveness of premarital screening in identifying carriers and preventing high-risk marriages. Continued expansion and public education about genetic counseling are crucial to reducing the burden of inherited hemoglobin disorders in Iraq.

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