A survey on Hemoglobin E Trait Prevalence, Clinical Manifestations, and Genetic Considerations at Shaheed Suhrawardy Medical College and Hospital

PROJECT REPORT

[*In the partial fulfillment of the requirements for the degree of Bachelor of Pharmacy]*

Submitted To

The Department of Pharmacy

Faculty of Health & Life Sciences

Daffodil International University

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APPROVAL

This project paper, **"A survey on Hemoglobin E Trait Prevalence, Clinical Manifestations, and Genetic Considerations at Shaheed Suhrawardy Medical College and Hospital",** submitted to the Department of Pharmacy, Faculty of Health & Life Sciences, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Pharmacy and approved as to its style and contents.

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DECLARATION

I hereby declare that this project report, **"A survey on Hemoglobin E Trait Prevalence, Clinical Manifestations, and Genetic Considerations at Shaheed Suhrawardy Medical College and Hospital",** is done by me under the supervision Ms. Aklima Akter Assistant Professor, Department of Pharmacy Faculty of Health & Life Sciences Daffodil International University. I am declaring that this project is my original work. I also declare that neither this thesis nor any part therefore has been submitted elsewhere for the award of bachelor degree.

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I might want to communicate my profound applause to the All-powerful Allah who has given me the capacity to finish my undertaking work and the chance to concentrate in this subject.

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Finally, I would like to express my gratitude towards my parents and other family members for their kind cooperation and encouragement which helped me in completion of this project.

My Parents,

The persons who always encourage me in every sphere of my life.

My teacher,

The persons who guided me in this process and the committee who kept me on track.

Abstract

In Southeast Asia and the surrounding regions, hemoglobin E, an abnormality of the human hemoglobin β-chain, is extensively spread. This survey aimed to investigate the prevalence, clinical manifestations, and genetic considerations associated with Hemoglobin E trait among patients at Shaheed Suhrawardy Medical College and Hospital. The examination is led by a questionnaires oriented survey, around 200 populations was being responded for this assessments. As per this survey most of the population 65% retorted that they have been well known about Hemoglobin E trait. (55%) haven't been experienced symptoms associated with Hemoglobin E trait. 25% responders retorted that they have been felt Jaundice/yellowing of the skin like symptoms. Conferring to that 38% responders retorted Hemoglobin E Trait is an inherited blood disorder. 60% responders retorted that they have been Hemoglobin electrophoresis tested for Hemoglobin E Trait. 30% participants retorted that they have been Genetic tested of the HBB gene for Hemoglobin E Trait. As per this investigation maximum responders (65%) replied that they haven't been aware of the inheritance pattern of Hemoglobin E Trait. 67% replied that they have been thought genetic counseling is important for individuals with Hemoglobin E Trait. In this investigation most of the responders (92%) replied that their family member have been Hemoglobin E Trait. 95% participants replied that they have been thought Hemoglobin E Trait is not affected daily life activities. Further research is warranted to explore the broader implications of Hemoglobin E trait and to optimize healthcare interventions for affected individuals and their families.

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Chapter 1
Introduction

1.1 Introduction

Hemoglobin E (HbE) trait is a common hemoglobinopathy prevalent in many parts of the world, particularly in regions where malaria is endemic, such as Southeast Asia. The HbE trait is characterized by the presence of an abnormal hemoglobin variant, resulting from a point mutation in the β-globin gene. In recent years, there has been growing interest among medical professionals and researchers in understanding the prevalence, clinical manifestations, and genetic considerations associated with HbE trait due to its implications for public health and clinical management [1]. The Shaheed Suhrawardy Medical College and Hospital, situated in Dhaka, Bangladesh, serves as a crucial healthcare institution in the region, catering to a diverse patient population. Given the geographical location and demographics of Bangladesh, the prevalence of hemoglobinopathies, including HbE trait, is of significant concern. Therefore, conducting a comprehensive survey focusing on HbE trait within the catchment area of Shaheed Suhrawardy Medical College and Hospital is paramount to understanding the epidemiology and clinical implications of this condition. This survey aims to provide an in-depth analysis of the prevalence of HbE trait among patients presenting at Shaheed Suhrawardy Medical College and Hospital, shedding light on its demographic distribution, clinical manifestations, and associated genetic factors [2]. By examining a large cohort of patients, this study seeks to elucidate the spectrum of clinical presentations associated with HbE trait, ranging from asymptomatic carriers to individuals with mild to moderate clinical symptoms. Furthermore, exploring the genetic determinants underlying HbE trait is crucial for enhancing our understanding of its inheritance pattern and facilitating genetic counseling for affected individuals and their families. Through molecular genetic analyses, this survey intends to identify common genetic polymorphisms associated with HbE trait within the study population, providing valuable insights into the genetic diversity and population dynamics of this hemoglobinopathy [3]. The findings of this survey hold significant implications for healthcare practitioners, policymakers, and researchers involved in the management and prevention of hemoglobinopathies, particularly HbE trait, in Bangladesh and similar regions. By delineating the prevalence, clinical characteristics, and genetic factors associated with HbE trait at Shaheed Suhrawardy Medical College and Hospital, this study aims to contribute to the development of targeted interventions, genetic screening

programs, and personalized management strategies for individuals affected by this condition [4].

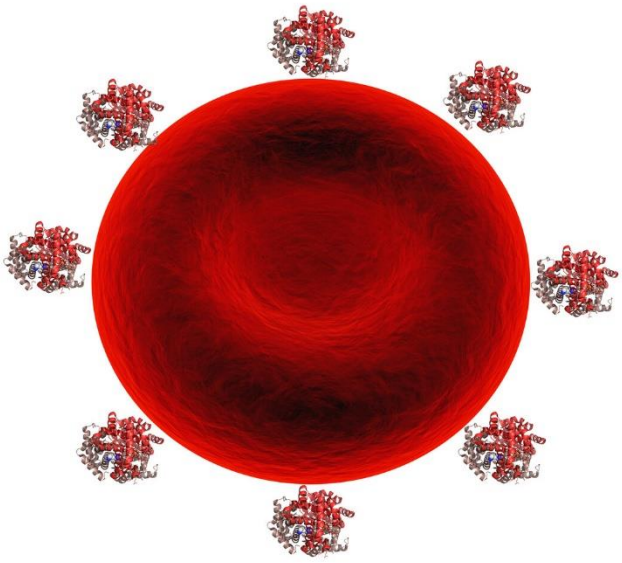

Figure 1: Hemoglobin E Disease

1.2 Etiology of Hemoglobin E (HbE) trait

Hemoglobin E (HbE) trait is a genetic condition characterized by the presence of an abnormal hemoglobin molecule called hemoglobin E. This trait is primarily found in populations from Southeast Asia, particularly in regions such as Thailand, Cambodia, Laos, and parts of India. The etiology of HbE trait lies in genetic mutations affecting the hemoglobin gene [5].

Here's a breakdown of the etiology:

1. **Genetic Mutation**: HbE trait is caused by a mutation in the HBB gene, which encodes the beta-globin subunit of hemoglobin. This mutation involves a single nucleotide substitution in the beta-globin gene, resulting in the replacement of glutamic acid with lysine at position 26 of the beta-globin chain. This change leads to the production of abnormal hemoglobin E molecules [6].

2. **Autosomal Recessive Inheritance**: HbE trait follows an autosomal recessive pattern of inheritance. This means that an individual must inherit two copies of the mutated gene (one from each parent) to manifest the trait. If an individual inherits only one copy of the mutated gene, they are carriers of the trait, known as heterozygotes.
3. **Geographic Distribution**: HbE trait is most prevalent in populations native to Southeast Asia, where the mutation likely originated. Migration and population movements have resulted in the spread of HbE to other parts of the world, particularly among individuals of Southeast Asian descent [7].
4. **Clinical Manifestations**: Individuals with HbE trait typically do not exhibit significant symptoms or health problems. However, they may experience mild anemia or exhibit characteristics of beta-thalassemia, particularly if they inherit another abnormal hemoglobin gene along with HbE.
5. **HbE Disease**: In some cases, individuals with HbE trait may develop a more severe condition known as HbE disease if they inherit two copies of the HbE mutation. HbE disease can cause moderate to severe anemia and may require medical intervention, such as blood transfusions, to manage symptoms [8].

1.3 Pathogenesis of Hemoglobin E trait

A mutation in the HBB gene, which codes for the production of the beta-globin protein, results in the hereditary condition known as hemoglobin E (HbE) characteristic. Hemoglobin E is the aberrant form of hemoglobin that is produced as a result of this abnormality. In areas like Southeast Asia and some regions of Africa where malaria is endemic, hemoglobin E trait is very common [9].

Here's the pathogenesis of Hemoglobin E trait:

Genetic Mutation:

Hemoglobin E trait is caused by a point mutation in the HBB gene on chromosome 11. This mutation results in the substitution of a single amino acid (glutamic acid to lysine) in the beta-globin chain of hemoglobin.

Abnormal Hemoglobin Production:

The mutation leads to the production of abnormal hemoglobin E, which forms when both the normal hemoglobin A and hemoglobin E are present. Hemoglobin E has altered properties compared to normal hemoglobin A, affecting its ability to carry oxygen [11].

Effects on Red Blood Cells (RBCs):

The presence of hemoglobin E can affect the function and lifespan of red blood cells. While individuals with Hemoglobin E trait generally do not experience significant symptoms, their red blood cells may have slightly reduced lifespan compared to those with normal hemoglobin.

Carrier State:

Individuals with Hemoglobin E trait are carriers of the genetic mutation. They typically do not experience severe symptoms associated with hemoglobinopathies like sickle cell disease or beta-thalassemia, although in certain cases, they may exhibit mild anemia or other hematological abnormalities [12].

Malaria Resistance:

Interestingly, carriers of Hemoglobin E trait may have some degree of protection against malaria. This is due to the fact that the presence of abnormal hemoglobin alters the environment within the red blood cells, making it less favorable for the malaria parasite to thrive. Consequently, individuals with Hemoglobin E trait may have a survival advantage in regions where malaria is prevalent.

Genetic Inheritance:

Hemoglobin E trait follows an autosomal recessive pattern of inheritance. This means that an individual must inherit two copies of the mutated HBB gene (one from each parent) to develop the more severe form of the disease, known as Hemoglobin E disease. Carriers of only one copy of the mutated gene typically do not exhibit symptoms but can pass the trait on to their offspring [13].

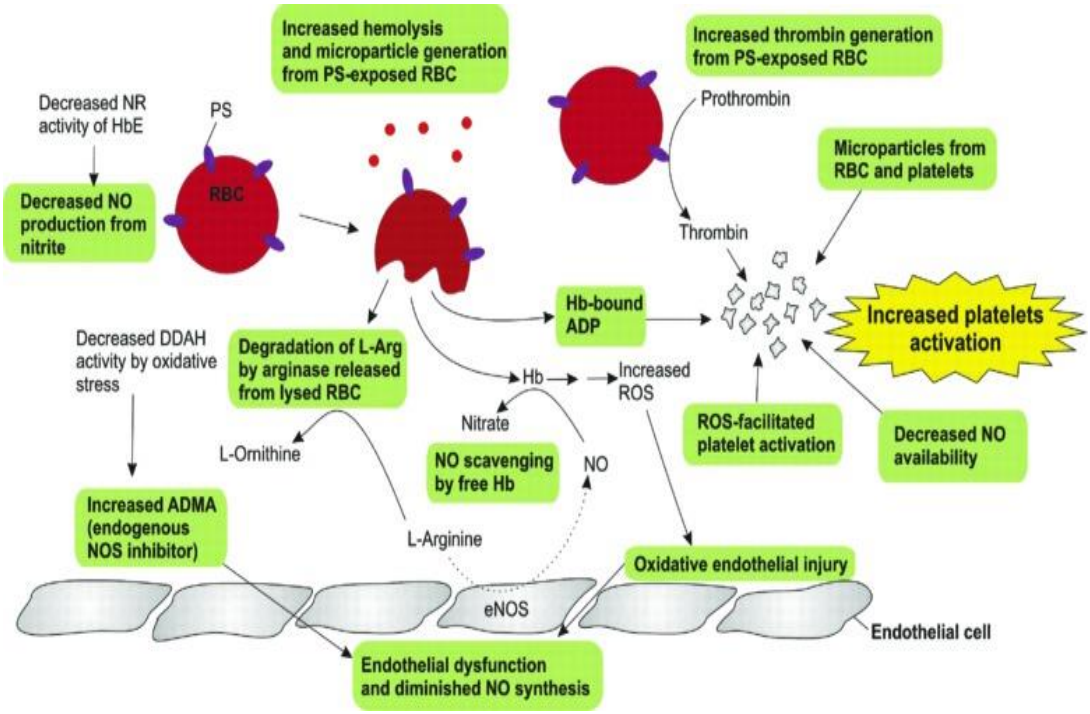

Figure 2: Pathogenesis of Hemoglobin E (HbE) trait

1.4 Heredity of Hemoglobin E (HbE) trait

Hemoglobin E (HbE) is an abnormal hemoglobin variant that results from a mutation in the HBB gene, which provides instructions for making a protein called beta-globin. This mutation leads to the production of an abnormal form of beta-globin, causing various hemoglobin disorders when inherited in combination with other hemoglobin variants [14].

Hemoglobin E trait (HbE trait) is typically inherited in an autosomal recessive pattern. This means that an individual must inherit two copies of the abnormal gene (one from each parent) to develop the trait [15].

- If both parents are carriers of the HbE trait (heterozygous), there is a 25% chance with each pregnancy that their child will inherit two copies of the abnormal gene and have HbE trait.
- If one parent has HbE trait and the other has a normal hemoglobin genotype, each child has a 50% chance of inheriting the HbE trait.
- If both parents have HbE trait, there is a 25% chance with each pregnancy that their child will inherit two copies of the abnormal gene from both parents, resulting in a more severe condition known as hemoglobin E beta-thalassemia, which can cause more significant health problems [16].

Individuals with HbE trait usually do not experience any symptoms or health problems, but they can pass the abnormal gene to their children. In regions where HbE trait is prevalent, such as parts of Southeast Asia, there may be a higher frequency of carriers in the population. Genetic counseling and testing are recommended for couples with a family history of hemoglobin disorders to understand the risk of passing on these conditions to their children [17].

1.5 Prevention of Hemoglobin E trait

Hemoglobin E (HbE) trait is a genetic condition characterized by the presence of abnormal hemoglobin, which can lead to mild anemia. Prevention of HbE trait primarily involves genetic counseling and education:

1. **Genetic Counseling**: Individuals who are carriers of the HbE trait should consider genetic counseling before planning a family. Genetic counselors can provide information about the

risk of passing the trait to offspring and discuss options such as prenatal testing and preimplantation genetic diagnosis [18].

2. **Prenatal Testing**: For couples who are carriers of the HbE trait, prenatal testing can be performed to determine if the fetus has inherited the trait. This information can help parents make informed decisions about their pregnancy and plan for appropriate medical care if the fetus is affected.
3. **Preimplantation Genetic Diagnosis (PGD)**: PGD is a technique used during in vitro fertilization (IVF) to screen embryos for genetic disorders before implantation. Couples at risk of having a child with HbE trait can undergo IVF with PGD to select embryos that do not carry the trait [19].
4. **Population Screening Programs**: In regions where HbE trait is prevalent, population screening programs can be implemented to identify carriers and provide genetic counseling and education. These programs can help raise awareness about the condition and reduce the incidence of affected births through informed family planning.
5. **Education and Awareness**: It's important to educate individuals and families about the inheritance pattern of HbE trait and its implications. This includes understanding the risks associated with carrier status and the importance of informed family planning decisions.
6. **Access to Healthcare Services**: Access to quality healthcare services, including prenatal care and genetic testing, is crucial for individuals and families affected by HbE trait. Ensuring access to these services can facilitate early detection, appropriate management, and informed decision-making [20].

While these measures can help prevent the transmission of HbE trait to future generations, it's essential to recognize that not all cases can be prevented. However, through proactive measures such as genetic counseling, prenatal testing, and education, individuals and families can make informed choices to manage the condition effectively [21].

Chapter 2
Purpose of the study

2.1 Purpose of the study

The purpose of the study investigating various aspects related to Hemoglobin E (HbE) trait within the context of the medical college and hospital setting.

- The study may aim to determine the prevalence of Hemoglobin E trait among the patient.
- It likely involves investigating the clinical manifestations associated with Hemoglobin E trait among patients.
- The study might explore various genetic aspects such as inheritance patterns, genetic mutations associated with HbE, and genetic predispositions to certain health conditions linked with HbE trait.
- The study could also evaluate the diagnostic methods and techniques used for identifying Hemoglobin E trait in patients.

Chapter 3
Literature Review

3.1 Hemoglobin E syndromes

Hemoglobin (Hb) E mutations are among the most prevalent and significant mutations globally. As a consequence, a diverse spectrum of ailments with mild to severe phenotypes are produced. Hb EE and Hb E trait are both minor diseases. Comparable to sickle β+ thalassemia, a combination of Hb E and Hb S (Hb SE) causes a sickle cell sickness syndrome. The notable variation in the clinical course amongst genotypes makes it crucial to differentiate Hb E diseases for diagnosis. If one is unfamiliar with the results, screening tests such as hemoglobin electrophoresis and high-pressure liquid chromatography (HPLC) may indicate further mutations. The most severe type of E syndromes, E β-thalassemia, affects one million people globally and is on the rise in North America. The kind of β-thalassemia change, Hb F levels, and co-inheritance of α-thalassemia are among the genetic modifiers that impact the phenotype. That being said, little is known about the cause of the phenotypic variability. According to a projected natural history study conducted in Sri Lanka, environmental moderators have a significant predictive impact. Acute and chronic complications are common during the clinical course of E β-thalassemia and have the potential to cause significant morbidity and mortality. According to recent research, these individuals have an elevated risk of thromboembolism due to a hypercoagulable state brought on by splenectomy. In no transfused individuals, morbidity from iron excess due to accelerated gastrointestinal absorption is prevalent [22].

3.2 Antioxidant in plasma of hemoglobin-E trait

Antioxidant levels were investigated in Thai individuals with hemoglobin E trait. Finding out if the HbE disease will affect the antioxidant level was the aim of this investigation. Fourteen HbE transmitters and 171 normally healthy subjects were among the 185 volunteer individuals that were enlisted. The Trolox comparable antioxidant capacity (TEAC) method was used to determine the antioxidant in each example. The present investigation found that the mean antioxidant concentration in the HbE trait group was 3.276 + 0.209 mm Trolox comparable, while it was 3.439 + 0.220 mm in the healthy group. The HbE trait group had a significantly lower antioxidant level ($p = 0.008$) [23].

3.3 Hemoglobin E disease and glycosylated hemoglobin

A frequently used metric to track long-term glycemic control of individuals with diabetes mellitus is glycosylated hemoglobin, or HbA1C. The precision of HbA1C techniques may be impacted by the existence of hemoglobin (Hb) variations. In North-East India and South-East Asia, the more prevalent Hb variation is hemoglobin E. The use of ion-exchange chromatography (high-pressure liquids chromatography) may not be capable to identify HbA1C in an amount of Hb E, although immunoassay methods and boronate affinity separation may be capable to calculate it. Nevertheless, if the outcome is associated with serum fructosamine and plasma glucose levels, it might be overestimated. This restriction on HbA1C measurement in individuals with Hb E and other Hb variations should be known to physicians [24].

Chapter 4
Methodology

4. Methodology

Choose a cross-sectional survey design to meet data from a representative sample of the population in Bangladesh.

- I have started work for this investigation in December 2023.

4.1 Data Collection:

- Develop a designed questionnaire that covers demographics, awareness about Hemoglobin E Trait, prevalence, and management practices.
- Pre-test the questionnaire to identify and address any issues.
- Employ trained interviewers for face-to-face or telephone interviews, depending on resources.
- Translate the questionnaire into Bengali for better understanding by the local population. Train a team of data collectors on the questionnaire and ethical considerations.
- Conduct face-to-face interviews, phone interviews, or online surveys, depending on the accessibility of the respondents. Ensure informed consent and data confidentiality.
- Some important data has been collected by reviewed number of related article paper from different website like Google scholar, research gate and PubMed.

4.2 Data Variables:

- Collect demographic information, including age, gender, educational background, occupation, and residence.
- Gather evidence associated to Understanding Prevalence & Management of Hemoglobin E Trait, such as the presence of symptoms, family history, triggers, severity, and healthcare utilization.
- Explore lifestyle factors, including smoking habits, dietary patterns, and physical activity.
- Assess environmental factors, such as air quality, housing conditions, and proximity to potential allergens.

4.3 Sample size

The test had **13 short-answer questions** and took roughly four to five minutes to finish.

- I have tried my best to collect all data from different profession people for gathering different types of information.
- The examination is led by a questionnaires oriented survey, **200 populations** was being responded for this assessments.

4.4 Data analysis strategy

Data analysis is the methodical application of statistical and/or logical tools for describing and illustrating, condensing and summarizing, and evaluating data. Use appropriate statistical software to analyze the collected data. Employ descriptive statistics to summarize demographic and prevalence data.

Chapter 5

Results & discussion

5.1 Age of Responders

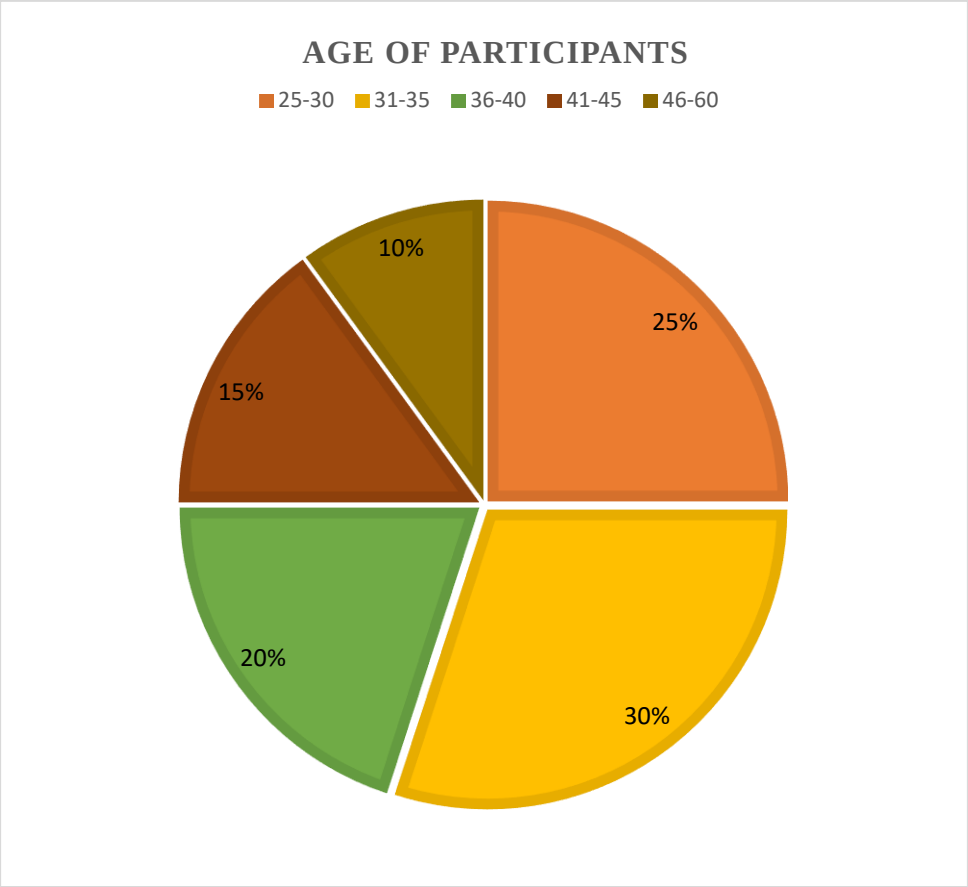

Figure 3: Age of Responders

Discussion: There were 200 participants in all for this investigation. Respondents ranging in age from 25 to 60 were between them. Here, the largest age group of participants (30%) was between 31 and 35 years old. Participants aged 25 to 30 made up 25% of the group, followed by those aged 36 to 40 (20%), 41 to 45 (15%), and 46 to 60 (10%).

5.2 Gender of Participants

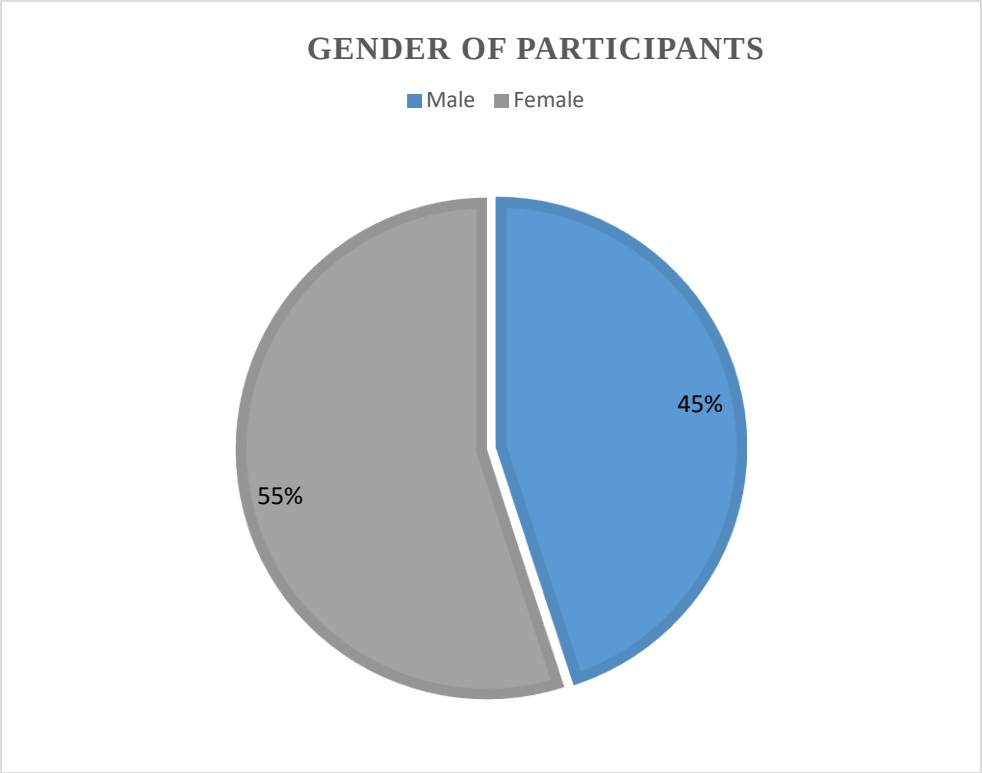

Figure 4: Gender of Participants

Discussion: The diverse gender representation in this inspection, here 45% male and 55% female members.

5.3 Professional Status of Responders

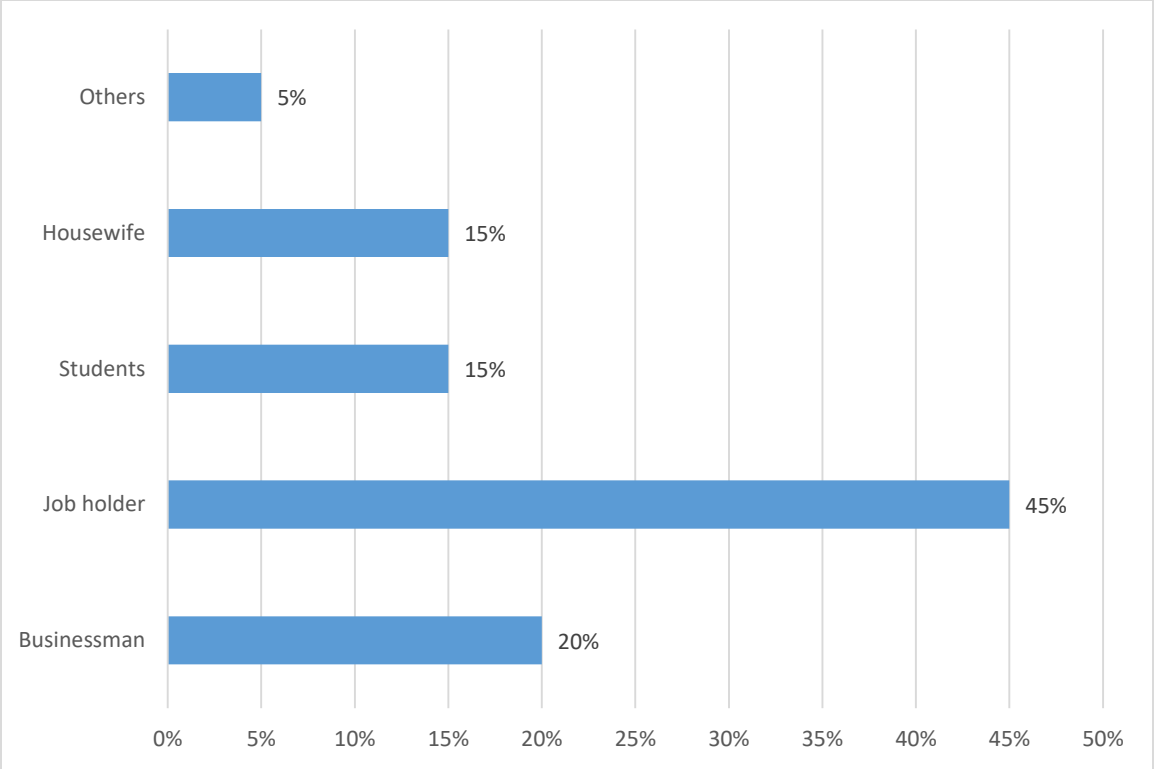

Figure 5: Professional Status of Responders

Discussion: Different professional personnel has been chosen for this survey. Conferring to figure 5 most of the participants are Job holder (45%), also 20% are businessman.

5.4 Familiar with Hemoglobin E trait

Q: How familiar are you with Hemoglobin E trait?

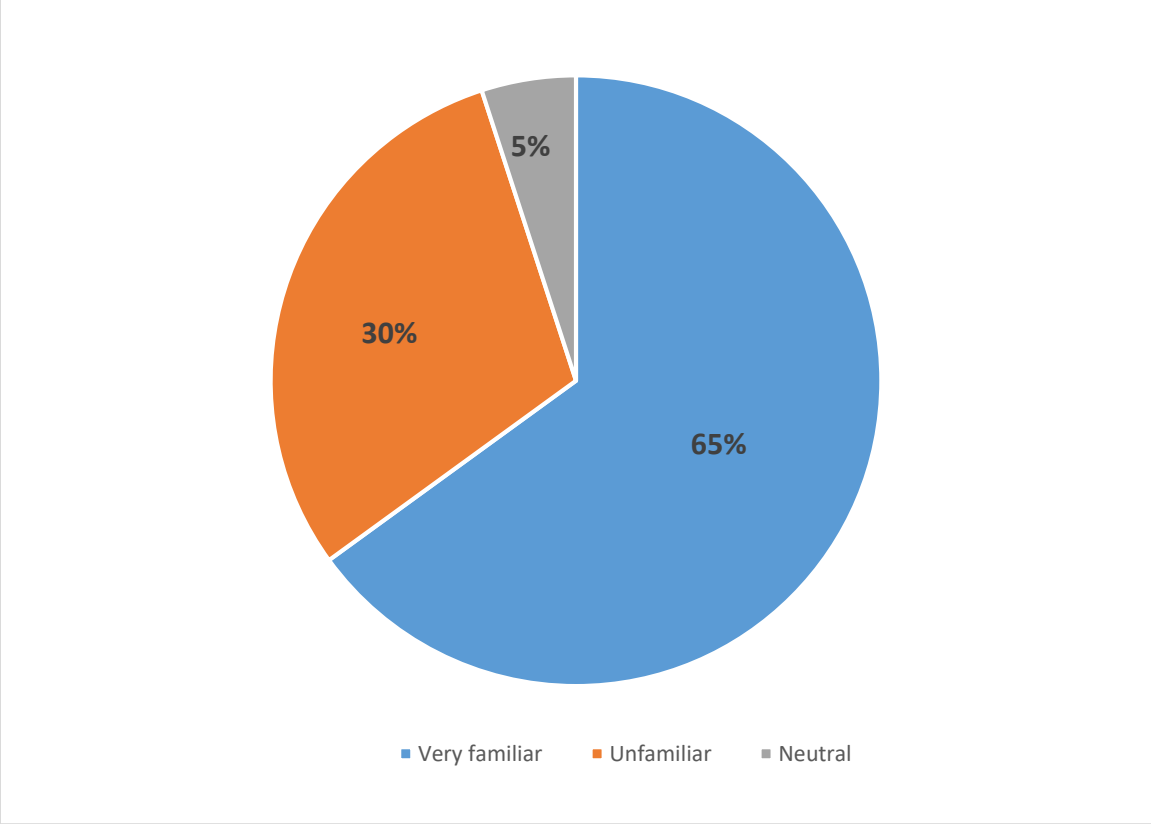

Figure 6: Familiar with Hemoglobin E trait

Discussion: The structural hemoglobin variation known as hemoglobin E (HbE) is incredibly widespread and is seen at elevated rates in several Asian countries. As per this survey most of the population 65% retorted that they have been well known about Hemoglobin E trait.

5.5 Experienced symptoms associated with Hemoglobin E Trait

Q: Have you experienced any symptoms associated with Hemoglobin E Trait?

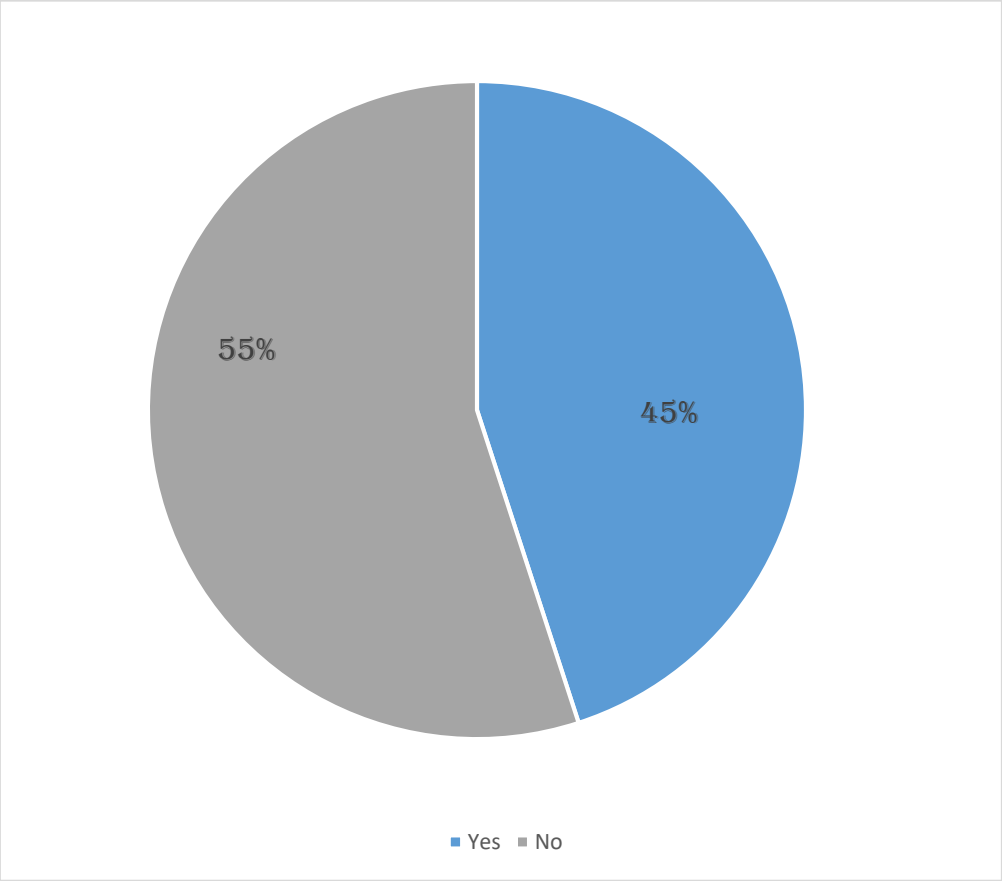

Figure 7: Experienced symptoms associated with Hemoglobin E Trait

Discussion: The most prevalent trait is hemoglobin E, which can be found in up to 30% of individuals from specific Southeast Asian regions. As per exploration extreme of the responders (55%) haven't been experienced symptoms associated with Hemoglobin E trait. 45% retorted that they have been experienced symptoms associated with Hemoglobin E trait.

5.6 Symptoms of Hemoglobin E Trait

Q: If so, what kind of symptoms have you experienced?

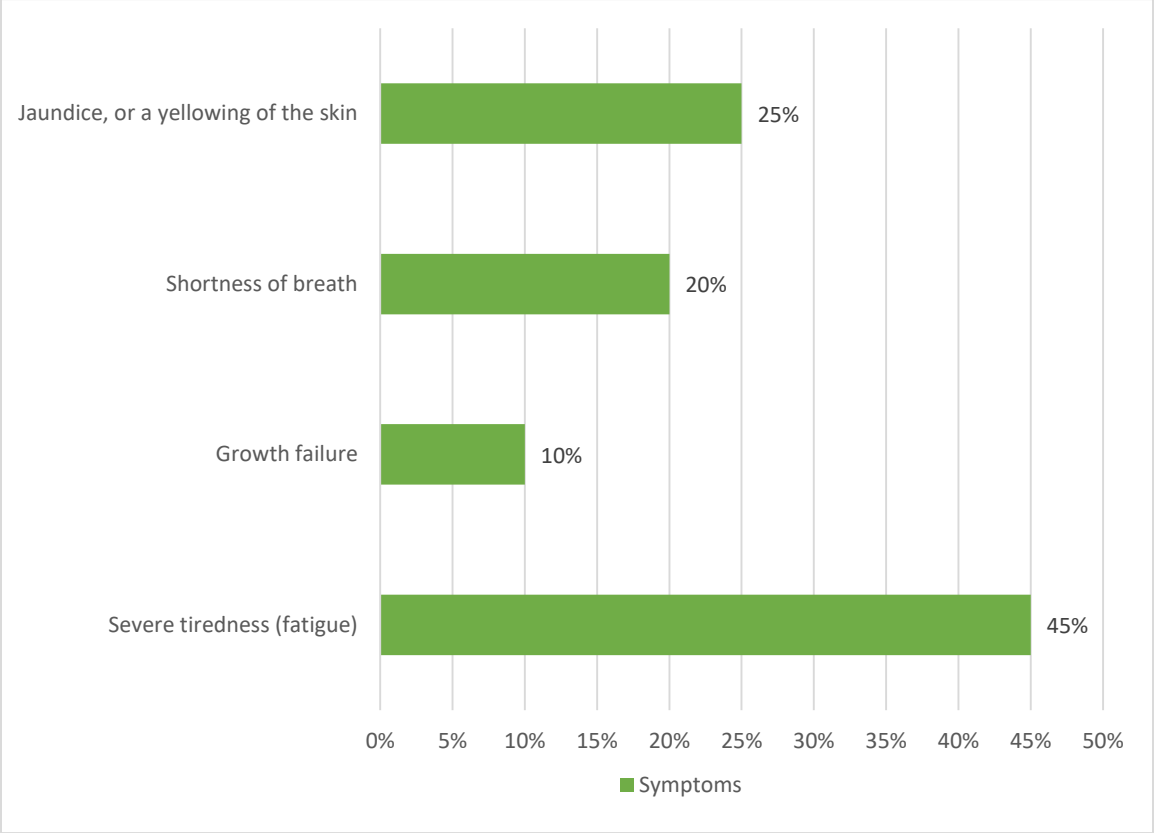

Figure 8: Symptoms of Hemoglobin E Trait

Discussion: The most commonly observed trait is hemoglobin E, which can be found in as many as thirty percent of individuals from specific Southeast Asian regions. In this investigation 45% participants replied that they have been experienced severe tiredness (fatigue). 25% responders retorted that they have been felt Jaundice/yellowing of the skin like symptoms & 20% responders retorted that they also have been felt shortness of breath like symptoms.

5.7 Type of disease

Q: "Do you know what kind of disease is Hemoglobin E Trait?"

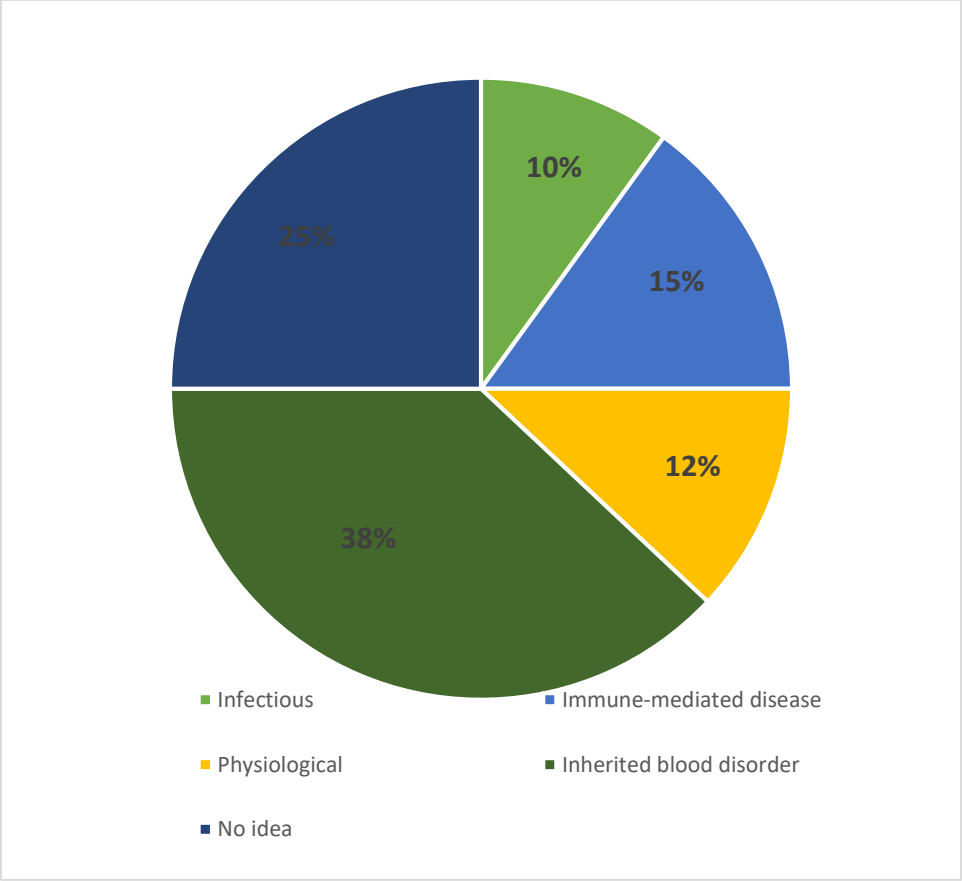

Figure 9: Type of disease

Discussion: The genetic blood condition known as hemoglobin E trait. This indicates that it is inherited from your parents. It results in an aberrant hemoglobin type that could give rise to moderate anemia. Conferring to that 38% responders retorted that they have been known Hemoglobin E Trait is an inherited blood disorder.

5.8 Medical tests or screenings related to Hemoglobin E Trait

Q: Have you undergone any medical tests or screenings related to Hemoglobin E Trait?

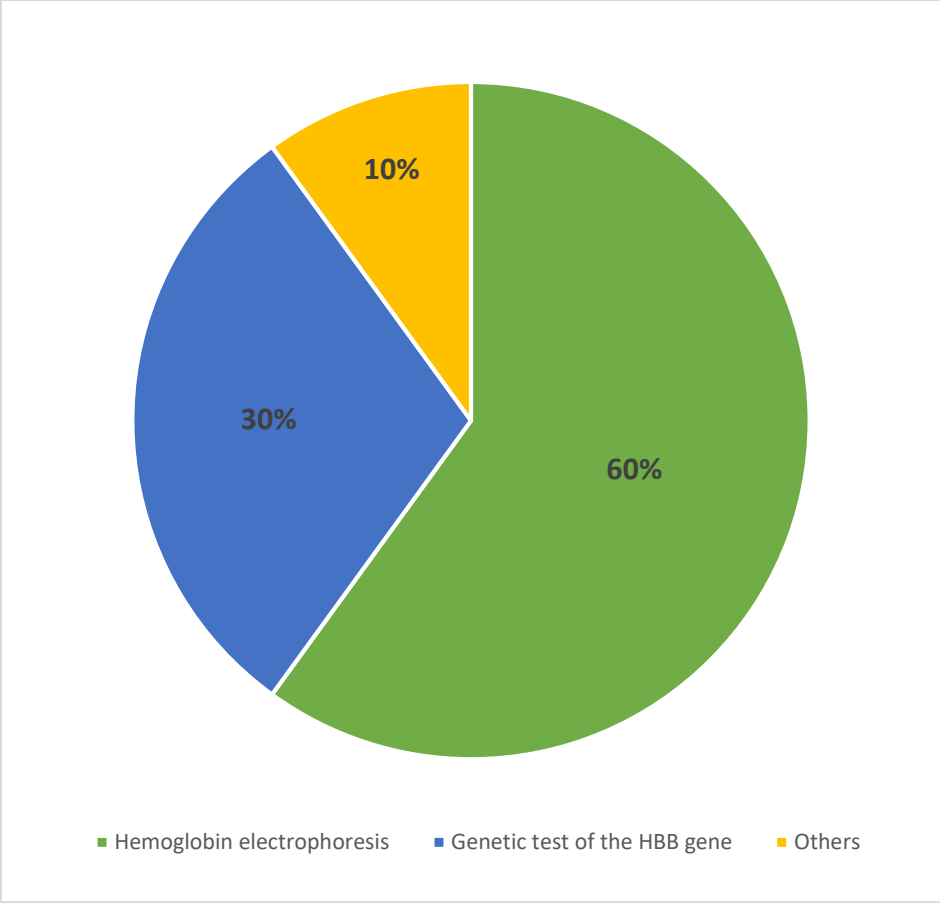

Figure 10: Medical tests or screenings related to Hemoglobin E Trait

Conversation: Hemoglobin electrophoresis counts hemoglobin and searches for hemoglobin types that are aberrant. Most frequently, it is employed in the diagnosis of hemoglobin diseases such as sickle cell disease, anemia, and others. As per this survey 60% responders retorted that they have been Hemoglobin electrophoresis tested for Hemoglobin E Trait. 30% participants retorted that they have been Genetic tested of the HBB gene for Hemoglobin E Trait.

5.9 Aware of the inheritance pattern of Hemoglobin E Trait

Q: Are you aware of the inheritance pattern of Hemoglobin E Trait?

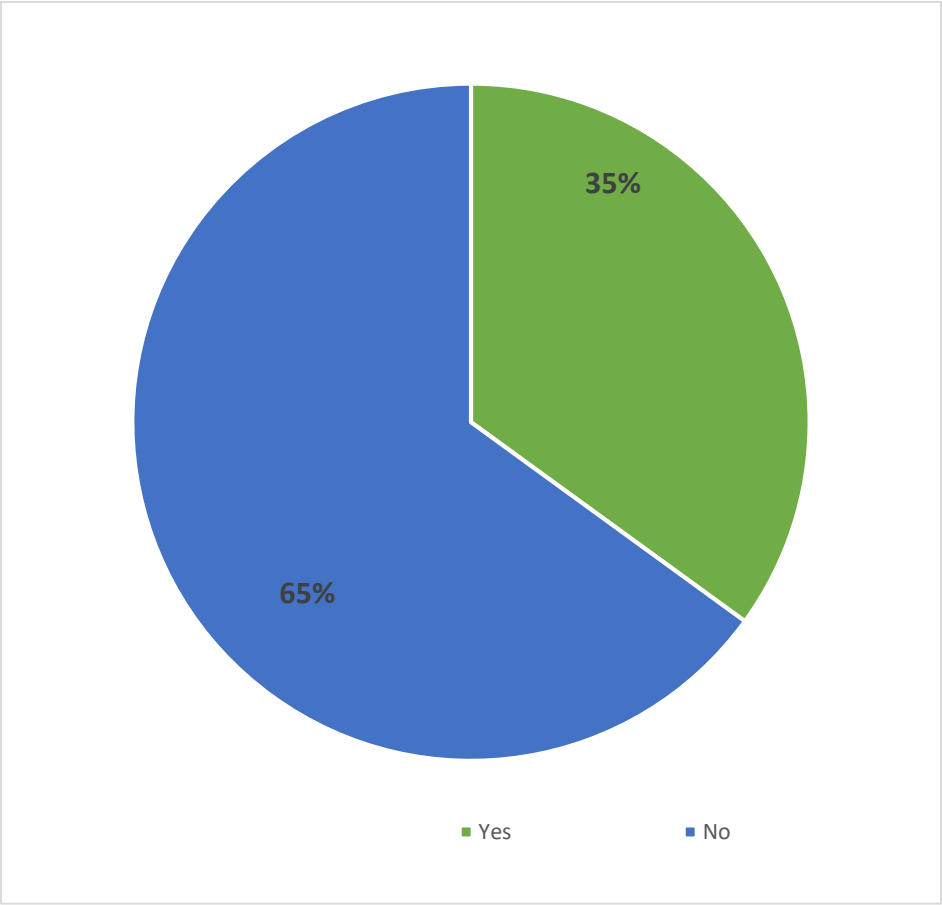

Figure 11: Aware of the inheritance pattern of Hemoglobin E Trait

Discussion: Hemoglobin E is inherited from your parents, just like hair and eye color. If one parent carries the hemoglobin E trait, there is a 50% (1 in 2) probability that every pregnancy will result in a kid with the trait. Hemoglobin E trait is not a disease and is usually asymptomatic. As per this investigation maximum responders (65%) replied that they haven't been aware of the inheritance pattern of Hemoglobin E Trait & 35% participants retorted that they have been aware of the inheritance pattern of Hemoglobin E Trait.

5.10 Genetic counseling

Q: Do you think genetic counseling is important for individuals with Hemoglobin E Trait?

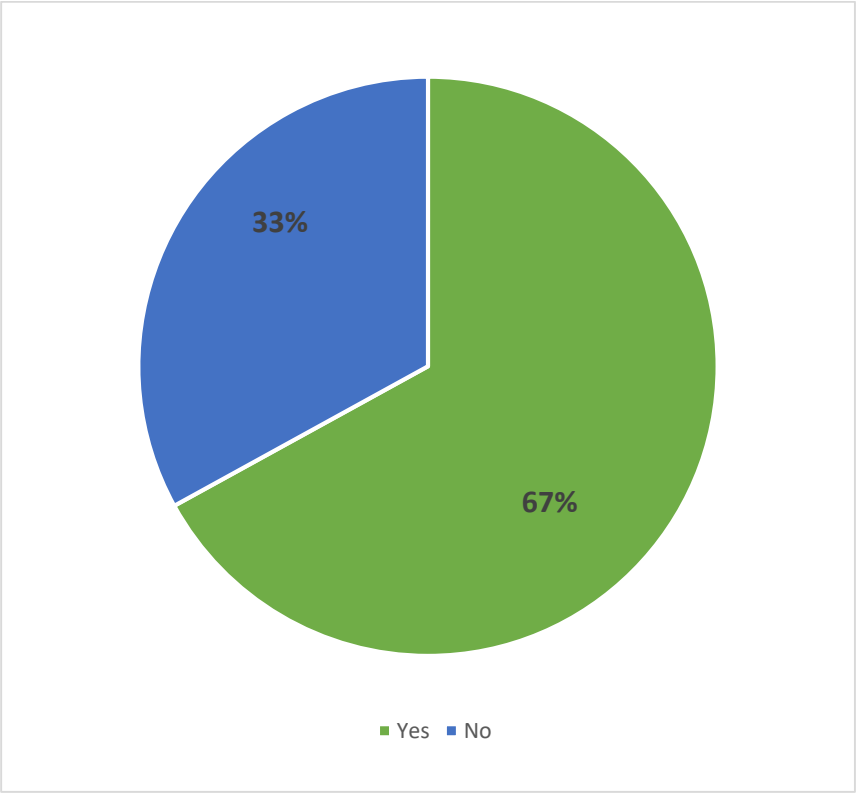

Figure 12: Genetic counseling

Discussion: Given the lifetime nature of these disorders, individuals with hemoglobin E characteristic should undergo genetic counseling to reduce the likelihood of inheriting these conditions. For this reason, it's critical to comprehend how the hemoglobin E characteristic is inherited and how it may impact your children's and grandchildren's wellness. According to the investigation 67% replied that they have been thought genetic counseling is important for individuals with Hemoglobin E Trait.

5.11 Family history of affected people

Q: Do you (affected people) have a family history (like father, mother and siblings) who has or had Hemoglobin E Trait?

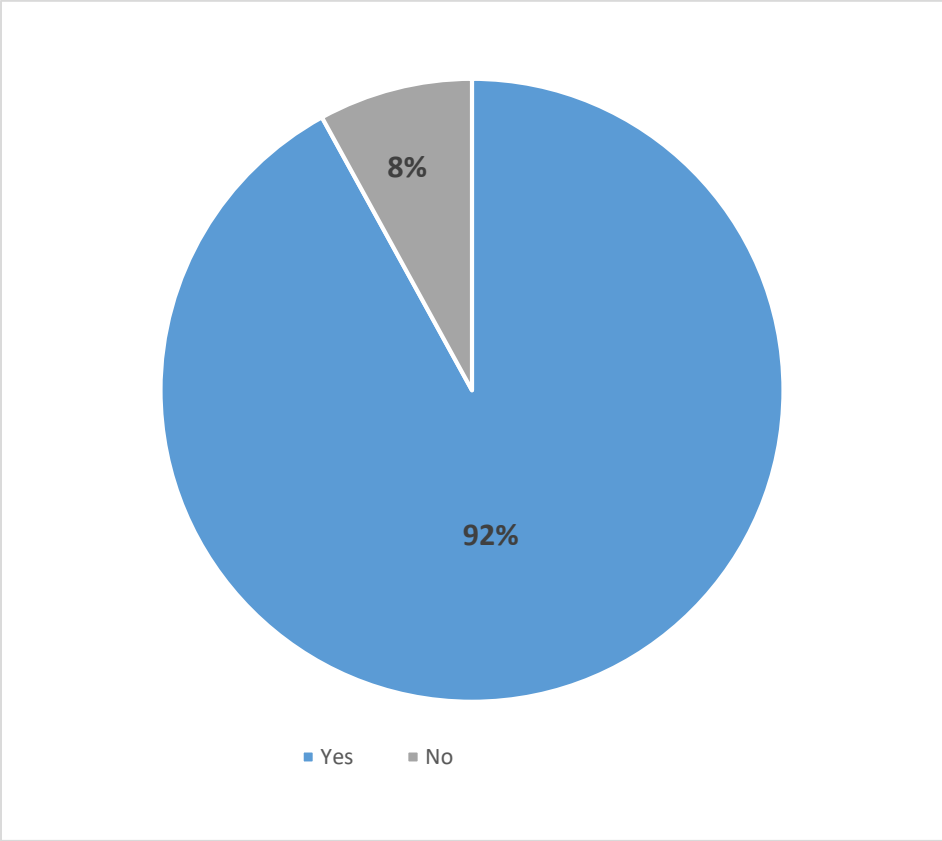

Figure 13: Family history

Discussion: The genetic blood condition known as hemoglobin E trait. This indicates that it is inherited from your parents. It results in an aberrant hemoglobin type that could give rise to moderate anemia. In this investigation most of the responders (92%) replied that their family member have been Hemoglobin E Trait.

5.12 Thought about iron rich food

Q: Do you think that iron rich food is necessaries to improve Hemoglobin E Trait patients?

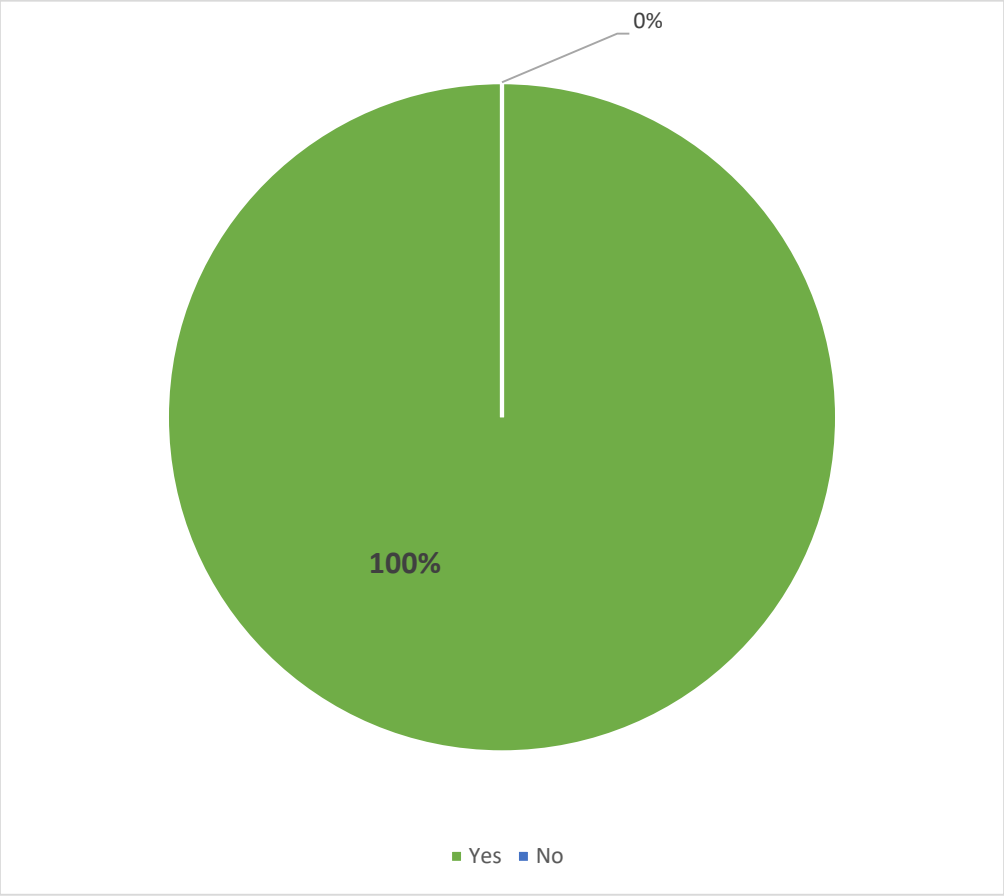

Figure 14: Thought about iron rich food

Discussion: A number of bodily processes, including the synthesis of hemoglobin, the oxygen-carrying molecule in your blood, depend heavily on iron. According to the survey, 100% responders replied that they have been thought iron rich food is necessaries to improve Hemoglobin E Trait patients.

5.13 Interfere with daily life

Q: Do you think Hemoglobin E Trait is affected daily life activities?

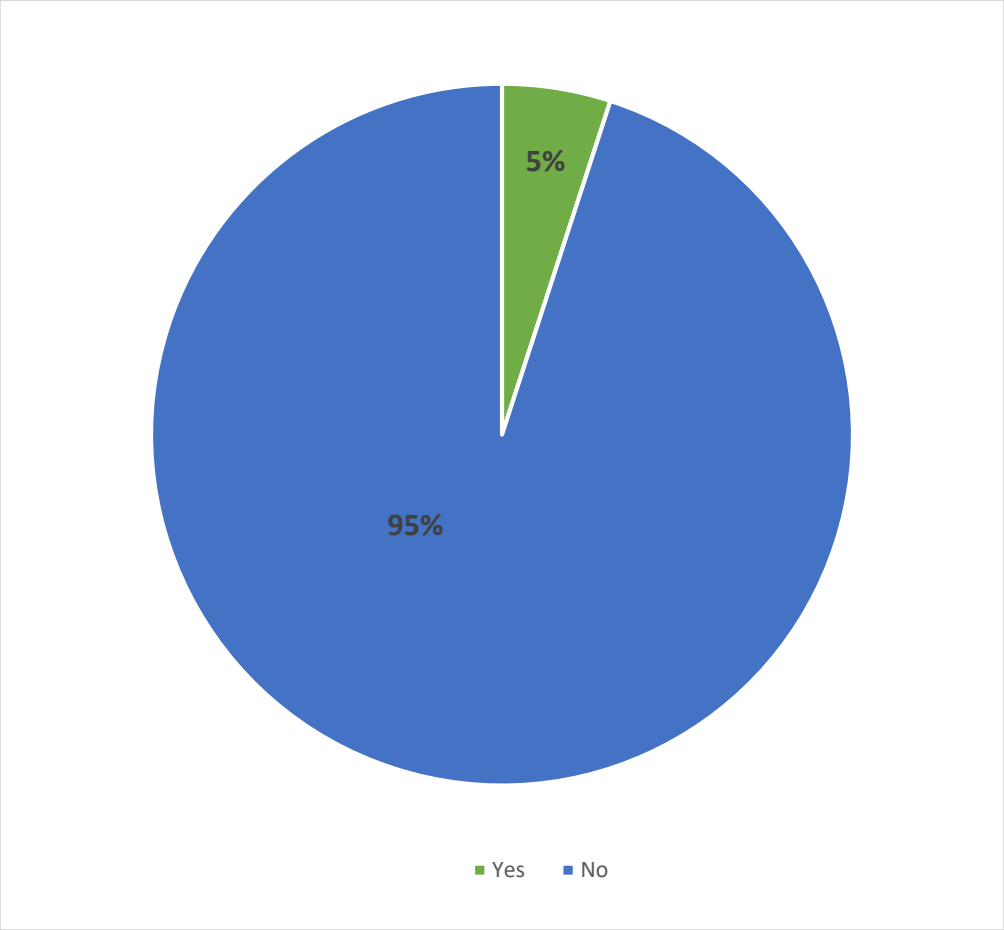

Figure 15: Interfere with daily life

Discussion: It's not an illness. Typically, it has no negative health effects. According to the assessment maximum 95% participants replied that they have been thought Hemoglobin E Trait is not affected daily life activities.

Chapter 6
Conclusion

6.1 Conclusion

In conclusion, this survey sheds light on the prevalence, clinical manifestations, and genetic considerations associated with Hemoglobin E trait at Shaheed Suhrawardy Medical College and Hospital. The findings underscore the significance of understanding the prevalence and clinical implications of this trait in the local population. It is evident that Hemoglobin E trait presents with a spectrum of clinical manifestations, ranging from asymptomatic to potentially severe complications, thus emphasizing the need for comprehensive screening and management strategies. Additionally, the genetic insights provided by this study contribute to our understanding of the inheritance patterns and molecular mechanisms underlying Hemoglobin E trait. Moving forward, further research and awareness initiatives are warranted to enhance early detection, genetic counseling, and personalized care for individuals with Hemoglobin E trait, ultimately improving clinical outcomes and quality of life for affected individuals and their families.

Chapter 7
Reference

Reference

1 Gibbons R, Higgs DR, Olivieri NF, Wood WG. The β and δ β thalassaemias in association with structural haemoglobin variants. In: Weatherall DJ, Clegg JB, eds. The Thalassaemia Syndromes (Fourth ed). Oxford, United Kingdom: Blackwell Science; 2001:393–449.

2 Old JM, Olivieri NF, Thien SL. Avoidance and population control. In: Weatherall DJ, Clegg JB, eds. The Thalassaemia Sydromes. United Kingdom: Blackwell Science; 2001:597–629.

3 de Silva S, Fisher CA, Premawardhena A, et al. Thalassaemia in Sri Lanka: implications for the future health burden of Asian populations. Sri Lanka Thalassaemia Study Group. Lancet. 2000;355:786–791.

4 Weatherall DJ. Introduction to the problem of hemoglobin EB thalassemia. J Pediatr Hematol Oncol. 2000;22:551.

5 Chotivanich K, Udomsangpetch R, Pattanapanyasat K, et al. Hemoglobin E: a balanced polymorphism protective against high parasitemias and thus severe P falciparum malaria. Blood. 2002;100:1172–1176.

6 Chernoff AI, Minnich V, Nanakorn S, et al. Studies on hemoglobin E. I. The clinical, hematologic, and genetic characteristics of the hemoglobin E syndromes. J Lab Clin Med. 1956;47:455–489.

7 Weatherall DJ, Clegg JB. Inherited haemoglobin disorders: an increasing global health problem. Bull World Health Organ. 2001;79:704–712.

8 Vichinsky EP, MacKlin EA, Waye JS, Lorey F, Olivieri NF. Changes in the epidemiology of thalassemia in North America: a new minority disease. Pediatrics. 2005;116:e818–e825.

9 Lorey F. Asian immigration and public health in California: thalassemia in newborns in California. J Pediatr Hematol Oncol. 2000;22:564–566.

10 Fucharoen S, Winichagoon P. Clinical and hematologic aspects of hemoglobin E beta-thalassemia. Curr Opin Hematol. 2000;7:106–112.

11 Lachant NA. Hemoglobin E: an emerging hemoglobinopathy in the United States. Am J Hematol. 1987;25:449–462.

12 Bain BJ. Other significant haemoglobinopathies. In: Haemoglobinopathy Diagnosis (2nd ed). Malden, MA: Blackwell Publishing; 2006:201–211.

13 Charoenkwan P, Wanapirak C, Thanarattanakorn P, et al. Hemoglobin E levels in double heterozygotes of hemoglobin E and SEA-type alpha-thalassemia. Southeast Asian J Trop Med Public Health. 2005;36:467–470.

14 Sanchaisuriya K, Fucharoen G, Sae-ung N, Jetsrisuparb A, Fucharoen S. Molecular and hematologic features of hemoglobin E heterozygotes with different forms of alpha-thalassemia in Thailand. Ann Hematol. 2003;82:612–616.

15 Jindadamrongwech S, Wisedpanichkij R, Bunyaratvej A, Hathirat P. Red cell parameters in alpha-thalassemia with and without beta-thalassemia trait or hemoglobin E trait. Southeast Asian J Trop Med Public Health. 1997;28:97–99.

16 Masiello D, Heeney MM, Adewoye AH, et al. Hemoglobin SE disease-a concise review. Am J Hematol. 2007;B2:643–649.

17 Fucharoen S, Ketvichit P, Pootrakul P, Siritanaratkul N, Piankijagum A, Wasi P. Clinical manifestation of beta-thalassemia/hemoglobin E disease. J Pediatr Hematol Oncol. 2000;22:552–557.

18 Datta P, Basu S, Chakravarty SB, et al. Enhanced oxidative cross-linking of hemoglobin E with spectrin and loss of erythrocyte membrane asymmetry in hemoglobin E/beta-thalassemia. Blood Cells Mol Dis. 2006;37:77–81.

19 Pootrakul P, Sirankapracha P, Hemsorach S, et al. A correlation of erythrokinetics, ineffective erythropoiesis, and erythroid precursor apoptosis in thai patients with thalassemia. Blood. 2000;96:2606–2612.

20 Jetsrisuparb A, Sanchaisuriya K, Fucharoen G, et al. Development of severe anemia during fever episodes in patients with hemoglobin E trait and hemoglobin H disease combinations. J Pediatr Hematol Oncol. 2006;28:249–253.

21 Premawardhena A, Fisher CA, Olivieri NF, et al. Haemoglobin E beta thalassaemia in Sri Lanka. Lancet. 2005;366:1467–1470.

22 Rees DC. Hemoglobin F and hemoglobin E/beta-thalassemia. J Pediatr Hematol Oncol. 2000;22:567–572.

23 Rees DC, Porter JB, Clegg JB, Weatherall DJ. Why are hemoglobin F levels increased in HbE/beta thalassemia? Blood. 1999;94:3199–3204.

24 Rees DC, Styles L, Vichinsky EP, Clegg JB, Weatherall DJ. The hemoglobin E syndromes. Ann N Y Acad Sci. 1998;850:334–343.