Personal Genetics Education Project

Ethical, Legal and Social Issues in Personal Genetics

SNAPSHOT

The Many Faces of Sickle Cell Disease

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SNAPSHOT

The Many Faces of Sickle Cell Disease

Do Now: watch this video and answer question 1 on the student worksheet. Please make sure to have the subtitles switched on.

What is the Cause of Sickle Cell Disease?

Sickle Cell Disease is caused by a common genetic variation that affects a person's red blood cells. The main building block of red blood cells is a protein called hemoglobin. Hemoglobin gives red blood cells their shape and is also key in binding and transporting oxygen.

The function of hemoglobin can be affected by differences in the DNA of the genes that code for this protein. We call these differences in the DNA code "variants". Some variants are more common than others, and some can affect a person's health.

For example, in one of the hemoglobin genes, there is a variant (**S**, Fig. 1) that causes red blood cells to have a 'sickle' or 'crescent' shape (like the letter 'C') and a variant (**A,** Fig. 1) that does not cause cells to sickle. The difference between these 2 variants is a single letter in the DNA code. People have two copies of this gene, one inherited from each biological parent. Therefore, people may carry these variants in 3 different combinations: SS, AA, or AS (Fig. 1).

- If a person has AA, their red blood cells typically have a flexible, round shape and can easily move through the body to deliver oxygen.

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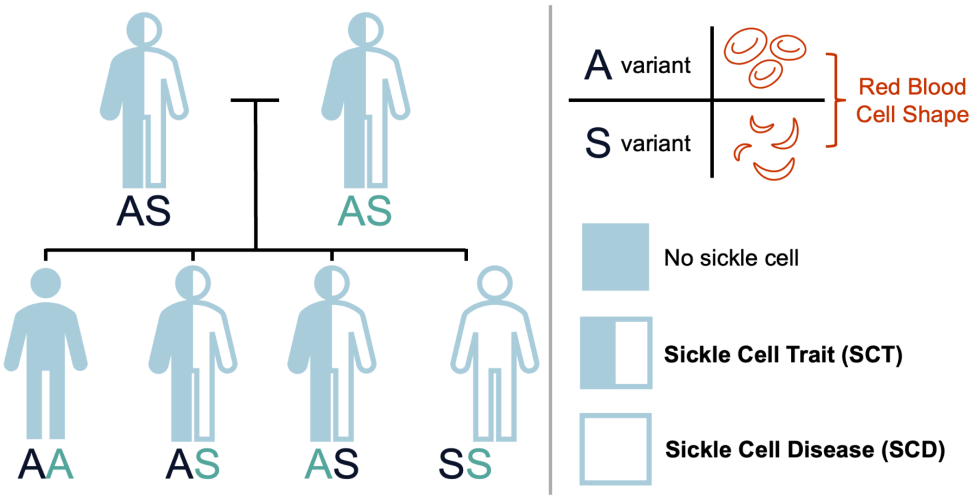

Figure 1: The Genetics of Sickle Cell

- If a person has SS, their red blood cells can have a rigid, 'sickle' shape. These cells have problems moving through the body and delivering oxygen to a person's organs and tissues. The result is a serious medical condition called **Sickle Cell Disease** (**SCD** - also known as Sickle Cell Anemia). This is the cause of some of the symptoms that the people in the video talked about, including fatigue, organ damage, acute pain crises, and possibly death.

- If a person has AS, this is known as **Sickle Cell Trait** (**SCT**). People with SCT do not typically have the symptoms of SCD, but are at increased risk for serious health complications in certain situations, such as exercising in extreme conditions. Extreme conditions can include very hot weather, longer-than-recommended training, and high altitude. (Note: These extreme conditions can cause distress - such as dizziness, weakness or vomiting during or after the workout - in any person, irrespective of their SCT status.)

Why is Sickle Cell Disease More Common in Certain Parts of the World?

Anyone can carry the variant that can cause red blood cells to sickle (S, Fig. 1). As we saw in the video, there are many people with SCD all around the world. However, SCD is more common in people with ancestry from certain parts of the world - including

Sub-Saharan Africa, parts of Asia, the Arabian Peninsula, and parts of the Mediterranean (Fig. 2, right panel). So why is it that although any person can carry the S variant, we see SCD more commonly in certain parts of the world? The short answer: malaria.

Malaria is an infectious disease that is caused by a parasite called Plasmodium. This parasite is transmitted to humans through the bites of female Anopheles mosquitoes. Even though this disease is preventable and curable, it can be life-threatening - especially if you do not have access to health services. In 2020, an estimated 627,000 people died of malaria. The majority were children under the age of 5.

What is the connection between malaria and SCD? When we look at a map of places that have had a recent history of malaria (Fig. 2, left panel), we see that SCD is more common in the same regions where malaria is more common. This is because having one copy of the S variant (SCT, Fig. 1) provides some protection against malaria.

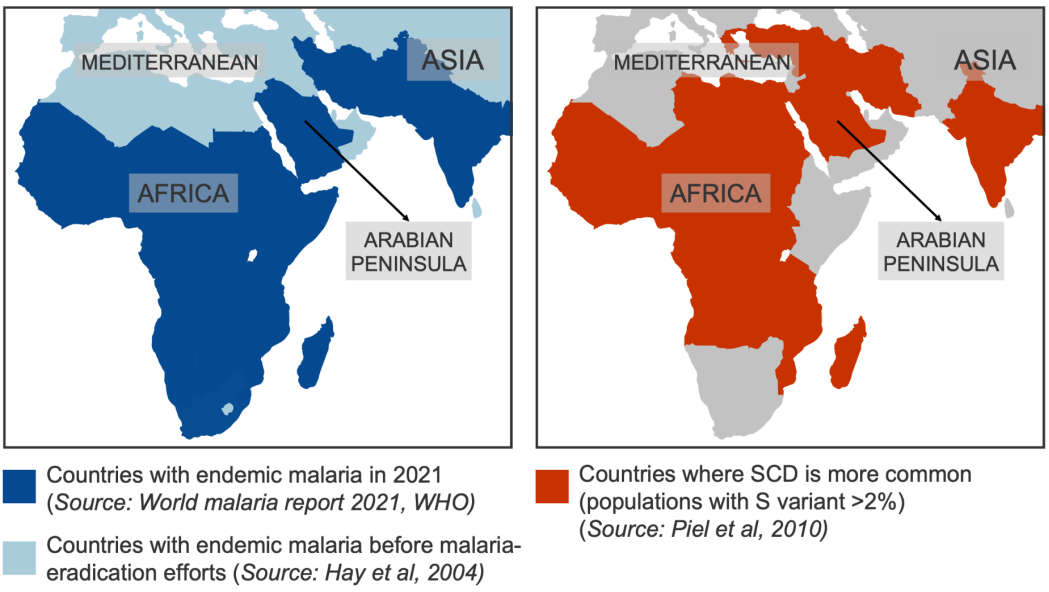

Figure 2: Distribution of Malaria and SCD

When people with SCT (AS) are infected with malaria, they tend to experience milder symptoms than people who do not have the S variant (AA). In regions where malaria is common, children with SCT are better able to survive into adulthood. And, if they have biological children, there is a 50-50 chance they will pass the S variant on to the next

generation (Fig. 1). This has allowed the frequency of the S variant (and, thus, SCT and SCD) to remain high in parts of the world where malaria is common - even though SCD (SS) has serious health impacts and does not protect a person from malaria. So, in short, the protective effect of SCT against malaria explains why the S variant (and, thus, SCD) is more common in people with ancestry from certain parts of the world (Fig. 2).

Do Now: answer question 2 on the student worksheet.

Some Key Takeaways about Sickle Cell Disease

Do Now: watch this clip from the video. Please make sure to have the subtitles switched on.

As we saw in this video clip, having SCD can be an isolating experience for many reasons. Some of this is due to misunderstandings about what SCD is and what it is not. Here are some key takeaways about SCD:

1. Any person - regardless of their race, ethnicity, or ancestry - can have SCD.

As we unpacked already, SCD is more common in people with ancestry from certain parts of the world (Fig. 2). In the US, for example, SCD is most common among people who identify as Black or African-American, as this group of people has ancestry from these regions. However, it is *incorrect*, and potentially harmful, to conclude that SCD is only found in people with specific ancestries. As we saw in the full video, some people have experienced delays in diagnosis and treatment because of misconceptions about how a person with SCD should look. Any person - regardless of their race, ethnicity, or ancestry - can carry the S variant that causes SCD.

2. SCD is genetic - it is *not* contagious.

Some people *incorrectly* believe that SCD is contagious, like a virus. Because of this misconception, some people with SCD have lost friendships, the chance to go to school, and their jobs. The fact is that SCD is *not* contagious. SCD is genetic - and occurs when

a person carries two copies of the S variant (Fig. 1). These variants in a person's DNA cannot be transferred to another person by infection.

3. The symptoms of SCD can differ from one person to the next. One reason is access to health care.

Do Now: watch this clip from the video. Please make sure to have the subtitles switched on.

Even though people with SCD carry two S variants in their hemoglobin genes, each person can experience different symptoms. Some people can have more severe SCD symptoms than others. As we saw in the video clip, one reason for this variation is disparities in health care. Access to health care, such as genetic testing and specialized SCD clinics, can make a big difference in people's lives. In the US, *all* newborn babies are screened for SCD (and several other conditions), which allows for earlier diagnosis and treatment. Current treatments for SCD include blood transfusions, antibiotics to prevent infections, bone marrow transplants, and medicines to reduce the frequency of painful crises. Efforts to develop new therapies are underway, bringing hope and also concerns about cost and who would be able to afford them. Newborn screening, combined with education, advocacy, and the availability of better treatments, have led to a dramatic increase in lifespan and quality of life for people with SCD. To further explain why there is variation in SCD symptoms, researchers are looking for other genetic and environmental factors that affect a person's experience of SCD.

Do Now: answer questions 3-5 on the student worksheet.

If you want to find out more about SCD and learn from people with SCD who have chosen to share their stories, this might be a helpful resource: www.notaloneinsicklecell.com.

Student Worksheet

Name: _____ Date: _____

1. What are some of the experiences that the people in the video shared about living with Sickle Cell Disease (SCD)? Name at least 5 different things.

2. In your own words, why is SCD more common in parts of the world with a history of malaria?

3. In the full video, the mother talked about how people did not believe that her son had SCD (timestamp: 1:35-1:45).
a. Why did people not believe that the mother's son has SCD?
b. And why is this belief incorrect?

4. In the full video, we also heard about the experiences of a sports coach (timestamp: 1:45-1:56).
a. Why did people not believe that the sports coach has SCD?
b. And why is this belief incorrect?

5. Why are *all* newborns in the US, no matter what ancestry they have, tested for SCD?

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Teacher's Guide

Related pgEd SNAPSHOT

'After 10 Years of Testing All College Athletes for Sickle Cell Trait, What Have We Learned?' is a companion module on Sickle Cell Trait that explores the history, successes, and limitations of the mandatory SCT screening program put in place by the National College Athletic Association (NCAA) to allow student athletes with SCT to safely participate in sports.

Additional Resources for Teachers

This CDC website is a place where people living with SCD share their stories and give tips for others living with SCD as well as their family and friends. In particular, Mimi's story reinforces the point that any person - regardless of their race, ethnicity, or ancestry - can have SCD, and highlights the problems that can arise when SCD is thought to only exist in people with specific ancestries.

The CDC also provides data and statistics on the prevalence of SCD and SCT in the United States that students can explore. As the CDC website notes, these numbers are estimates due to limits in the data that are currently available.

Question 4 on the students worksheet highlights the story of someone who was denied SCD treatment and was labeled as a drug seeker. This article gives an overview of current literature on pain management of SCD and the barriers experienced by people with SCD in getting the medication and treatment they need.

This article gives an overview of the research literature on how SCT protects against malaria, as well as links to further resources.

Student Worksheet: Teacher Notes

1. Answers to this question will vary, but can include things such as: descriptions of SCD health complications (e.g.: pain crises, being in a wheelchair, hip replacement surgery, stroke), experiences of discrimination (e.g.: losing job or friends), lack of access to health care, and experiences of social isolation. But also: increased education and understanding about SCD, increase in life expectancy and quality of life due to better SCD treatment, and shared stories by people in the video on how they do not see SCD as a disability and do not let their lives be defined by it.

2. When people with SCT (AS) are infected with malaria, they tend to experience milder symptoms than people who do not have the S variant (AA). In regions where malaria is common, children with SCT are better able to survive into adulthood. And, if they have biological children, there is a 50-50 chance they will pass the S variant on to the next generation (Fig. 1). This has allowed the frequency of the S variant (and, thus, SCT and SCD) to remain high in parts of the world where malaria is common - even though SCD (SS) has serious health impacts and does not protect a person from malaria.

3. (a) Because he is white. (b) Any person - regardless of their race, ethnicity, or ancestry - can have SCD.

4. (a) Because he looks fit and healthy, they told him that he cannot have SCD and treated him as a drug seeker. (b) A person who looks healthy and in good physical shape can have SCD.

5. Because even though SCD is more common in people with ancestry from certain parts of the world (Fig. 2), any person - regardless of their race, ethnicity, or ancestry - can carry the S variant that causes SCD.