Glucose-6-phosphate dehydrogenase deficiency

Glucose-6-phosphate dehydrogenase deficiency is a genetic disorder that occurs almost exclusively in males. This condition mainly affects red blood cells, which carry oxygen from the lungs to tissues throughout the body. In affected individuals, a defect in an enzyme called glucose-6-phosphate dehydrogenase causes red blood cells to break down prematurely. This destruction of red blood cells is called hemolysis.

The most common medical problem associated with glucose-6-phosphate dehydrogenase deficiency is hemolytic anemia, which occurs when red blood cells are destroyed faster than the body can replace them. This type of anemia leads to paleness, yellowing of the skin and whites of the eyes (jaundice), dark urine, fatigue, shortness of breath, and a rapid heart rate. In people with glucose-6-phosphate dehydrogenase deficiency, hemolytic anemia is most often triggered by bacterial or viral infections or by certain drugs (such as some antibiotics and medications used to treat malaria). Hemolytic anemia can also occur after eating fava beans or inhaling pollen from fava plants (a reaction called favism).

Glucose-6-phosphate dehydrogenase deficiency is also a significant cause of mild to severe jaundice in newborns. Many people with this disorder, however, never experience any signs or symptoms and are unaware that they have the condition.

Frequency

An estimated 400 million people worldwide have glucose-6-phosphate dehydrogenase deficiency. This condition occurs most frequently in certain parts of Africa, Asia, the Mediterranean, and the Middle East. It affects about 1 in 10 African American males in the United States.

Causes

Glucose-6-phosphate dehydrogenase deficiency results from mutations in the G6PD gene. This gene provides instructions for making an enzyme called glucose-6-phosphate dehydrogenase. This enzyme is involved in the normal processing of carbohydrates. It also protects red blood cells from the effects of potentially harmful molecules called reactive oxygen species, which are byproducts of normal cellular functions. Chemical reactions involving glucose-6-phosphate dehydrogenase produce compounds that prevent reactive oxygen species from building up to toxic levels within red blood cells.

If mutations in the G6PD gene reduce the amount of glucose-6-phosphate dehydrogenase or alter its structure, this enzyme can no longer play its protective role. As a result, reactive oxygen species can accumulate and damage red blood cells. Factors such as infections, certain drugs, or ingesting fava beans can increase the
levels of reactive oxygen species, causing red blood cells to be destroyed faster than the body can replace them. A reduction in the number of red blood cells causes the signs and symptoms of hemolytic anemia.

Researchers believe that people who have a \textit{G6PD} mutation may be partially protected against malaria, an infectious disease carried by a certain type of mosquito. A reduction in the amount of functional glucose-6-phosphate dehydrogenase appears to make it more difficult for this parasite to invade red blood cells. Glucose-6-phosphate dehydrogenase deficiency occurs most frequently in areas of the world where malaria is common.

\textbf{Inheritance Pattern}

This condition is inherited in an 
\textit{X}-linked recessive pattern. The gene associated with this condition is located on the \textit{X} chromosome, which is one of the two sex chromosomes. In males (who have only one \textit{X} chromosome), one altered copy of the gene in each cell is sufficient to cause the condition. In females (who have two \textit{X} chromosomes), a mutation would have to occur in both copies of the gene to cause the disorder. Because it is unlikely that females will have two altered copies of this gene, males are affected by \textit{X}-linked recessive disorders much more frequently than females. A characteristic of \textit{X}-linked inheritance is that fathers cannot pass \textit{X}-linked traits to their sons.

\textbf{Other Names for This Condition}

- deficiency of glucose-6-phosphate dehydrogenase
- G6PD deficiency
- G6PDD
- glucose 6 phosphate dehydrogenase deficiency

\textbf{Diagnosis & Management}

\textbf{Genetic Testing Information}

- What is genetic testing?
  
  /primer/testing/genetictesting

- Genetic Testing Registry: Glucose 6 phosphate dehydrogenase deficiency
  

\textbf{Research Studies from ClinicalTrials.gov}

- ClinicalTrials.gov
  
  https://clinicaltrials.gov/ct2/results?cond=%22glucose-6-phosphate+dehydrogenase+deficiency%22
Other Diagnosis and Management Resources

- Baby's First Test
  https://www.babysfirsttest.org/newborn-screening/conditions/glucose-6-phosphate-dehydrogenase-deficiency

- MedlinePlus Encyclopedia: Glucose-6-phosphate dehydrogenase deficiency
  https://medlineplus.gov/ency/article/000528.htm

- MedlinePlus Encyclopedia: Glucose-6-phosphate dehydrogenase test
  https://medlineplus.gov/ency/article/003671.htm

- MedlinePlus Encyclopedia: Hemolytic anemia
  https://medlineplus.gov/ency/article/000571.htm

- MedlinePlus Encyclopedia: Newborn jaundice
  https://medlineplus.gov/ency/article/001559.htm

Additional Information & Resources

Health Information from MedlinePlus

- Encyclopedia: Glucose-6-phosphate dehydrogenase deficiency
  https://medlineplus.gov/ency/article/000528.htm

- Encyclopedia: Glucose-6-phosphate dehydrogenase test
  https://medlineplus.gov/ency/article/003671.htm

- Encyclopedia: Hemolytic anemia
  https://medlineplus.gov/ency/article/000571.htm

- Encyclopedia: Newborn jaundice
  https://medlineplus.gov/ency/article/001559.htm

- Health Topic: Anemia
  https://medlineplus.gov/anemia.html

- Health Topic: G6PD Deficiency
  https://medlineplus.gov/g6pddeficiency.html

- Health Topic: Newborn Screening
  https://medlineplus.gov/newbornscreening.html

Genetic and Rare Diseases Information Center

- Glucose-6-phosphate dehydrogenase deficiency
  https://rarediseases.info.nih.gov/diseases/6520/glucose-6-phosphate-dehydrogenase-deficiency
Educational Resources

• KidsHealth from the Nemours Foundation
  https://kidshealth.org/en/parents/g6pd.html

• MalaCards: anemia, nonspherocytic hemolytic, due to g6pd deficiency
  http://www.malacards.org/card/anemia_nonspherocytic_hemolytic_due_to_g6pd_deficiency

• Malaria Atlas Project
  https://map.ox.ac.uk/research-project/duffy-negativity/

• Orphanet: NON RARE IN EUROPE: Glucose-6-phosphate-dehydrogenase deficiency
  https://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=362

Patient Support and Advocacy Resources

• Metabolic Support UK
  https://www.metabolicsupportuk.org/

• National Organization for Rare Disorders (NORD)
  https://rarediseases.org/rare-diseases/glucose-6-phosphate-dehydrogenase-deficiency/

• Resource list from the University of Kansas Medical Center
  http://www.kumc.edu/gec/support/metaboli.html

Scientific Articles on PubMed

• PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28Glucosephosphate+Dehydrogenase+Deficiency%5BMAJR%5D%29+AND+%28glucose-6-phosphate+dehydrogenase+deficiency%5BTIAB%5D%29+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+1440+days%22%5Bdp%5D

Catalog of Genes and Diseases from OMIM

• GLUCOSE-6-PHOSPHATE DEHYDROGENASE
  http://omim.org/entry/305900

Medical Genetics Database from MedGen

• Deficiency of glucose-6-phosphate dehydrogenase
Sources for This Summary

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/18177777

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/16225031

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/27040960

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/23534950

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/19233695

Reprinted from Genetics Home Reference: 

Reviewed: May 2017
Published: September 11, 2018

Lister Hill National Center for Biomedical Communications
U.S. National Library of Medicine
National Institutes of Health
Department of Health & Human Services