How HbAS and HbAC Heterozygotes Manifest Their Differences From HbAA Individuals At The Hemogram Level

Objective
To determine if healthy carriers of hemoglobin S and hemoglobin C have different hemogram profile when compared with those found in healthy adult homozygote hemoglobin individuals. A significant difference would show that heterozygosity in HbAS and HbAC individuals is manifested at the hematocrit level.

Background
- Understanding of how beta-globin mutations present phenotypically continues to increase
- Hemogram profiles can be used to measure how sickle cell disease manifests.
  - **Hematocrit** – Volume of red blood cells compared to the total blood volume (Billlett, 1990)
  - **Mean Cell Volume (MCV)** – Measurement of the average size and volume of a red blood cell (Maner & Moosavi, 2019)
  - **Mean Cell Hemoglobin (MCH)** – Amount of Hemoglobin per red blood cell (Sarma, 1990)
  - **Mean Cell Hemoglobin Concentrating (MCHC)** – The amount of hemoglobin per unit volume (Sarma, 1990)
  - MCV and MCH values are lower in homozygous sickle cell anemia (HbSS) cases than in individuals who are homozygotes for adult hemoglobin (Hb AA) (Akinbami et al., 2012)
  - MCV used to measure effectiveness of Hydroxyurea treatment in Sickle Cell Anemia patients (Queiroz et al., 2013).
  - Hydroxyurea increases MCV and synthesis of fetal hemoglobin HbF.
  - **Could there be a difference in hematocrit, MCV, MCH, and MCHC in carriers of hemoglobin C and hemoglobin S?**

Methods
- Participants:
  - Three Afro-Brazilian Quilombos communities, in the States of Tocantins and Goiás.
  - Three populations ranging from urban, semi urban and rural.
- Genotype:
  - HbAA (n=316)
  - HbAS (n=12)
  - HbAC (n=12)
- Materials:
  - Hemogram Data: Hematocrit, MCV, MCH, MCHC
- Analysis:
  - We compared the groups with Kruskal-Wallis test because of the small sample sizes of two of the groups.

Results

<table>
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<tr>
<th></th>
<th>Hematocrit</th>
<th>MCV</th>
<th>MCH</th>
<th>MCHC</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbAA</td>
<td>43.00 %</td>
<td>87.39 fL</td>
<td>28.99 pg</td>
<td>33.14 g/dl</td>
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<tr>
<td>HbAC</td>
<td>40.22 %</td>
<td>82.42 fL</td>
<td>28.86 pg</td>
<td>35.0 g/dl</td>
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<td>HbAS</td>
<td>39.94 %</td>
<td>79.06 fL</td>
<td>26.48 pg</td>
<td>34.0 g/dl</td>
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<table>
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Discussion
- There is variation in hemogram profiles between the genotypes
  - **Hematocrit** values were lower in HBAC and HBS genotypes rather than HBAA
  - **MCV** values were lower in HBAC and HBAS (especially in HBAS) than in HBAA
  - **MCH** values were similar in HBAA and HBAC, but lower in HBAS
  - **MCHC** levels were similar in HBAA and HBAC but lower in HBAS

- MCV is a good indicator of differences among homozygous AA, AS, and AC
- This is a co-dominant system and should be treated as such.
- Environmental factors can also influence the results of a hemogram profile (Akinbami et al., 2012; Maner & Moosavi, 2019)
- Diet, smoking, alcohol consumption, altitude
- These suggest that genetic variation and environmental pressures can result in carriers of hemoglobin C and hemoglobin S presenting on a spectrum

Recommendations for Future Research
- Consideration of diet, alcohol consumption, and smoking
- Variation between males and females to account for menstrual cycle effects on the hemogram profile.

References