The effects of an agrarian diet intervention on inflammation and gut microbiome composition in HIV-infected individuals in Colorado

January 11th, 2021

Background & Introduction

In the United States, 1.2 million people are infected with HIV and a high percentage are men who have sex with men (MSM) [1]. HIV comorbidities include cardiovascular disease, metabolic disease, and chronic inflammation, which are all associated with gut microbiome dysbiosis. Less systemic inflammation in HIV+ individuals is related to reduced mortality risk [2]. The gut microbiome composition of HIV+ individuals and HIV- MSM in the US is predominantly Prevotella rich and Bacteroides poor (PrevR/BacP) [3]. The Western diet (WD), common in the US, differs from the agrarian diet (AD) consumed by healthy Prevotella-rich populations in Malawi and Venezuela [4]. This implies that HIV- and HIV- MSM may consume inadequate nutrients for their gut bacteria. Therefore, we performed a clinical trial to assess the effects of an AD on HIV-infected individuals.

Hypothesis:
An agrarian diet for PrevR/BacP HIV+ individuals and HIV- MSM individuals will have beneficial health effects as measured by inflammatory markers.

Table 1. Standard Diet Composition of Western and Agrarian Diets

<table>
<thead>
<tr>
<th>Diet Composition</th>
<th>Western</th>
<th>Agrarian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>15% (62g)</td>
<td>15% (66.75g)</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>55% (228g)</td>
<td>70% (311.5g)</td>
</tr>
<tr>
<td>Fiber</td>
<td>18g</td>
<td>45g</td>
</tr>
<tr>
<td>Sugar</td>
<td>114g</td>
<td>67g</td>
</tr>
<tr>
<td>Sodium</td>
<td>3650g</td>
<td>1325g</td>
</tr>
<tr>
<td>Energy</td>
<td>2000kcal</td>
<td>2000kcal</td>
</tr>
<tr>
<td>Processed foods</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Methods

A four-week clinical trial on 90 HIV+ and HIV- individuals. Data collected at baseline (T1), and after 2 (T2) and 4 (T3) weeks.

Food preparation:
- Weeks 1 - 2: nutrition core prepared
- Weeks 3 - 4: study participants counseled/prepared food at home

Data collected:
- Demographic
- Questionnaires: sexual behavior, gastrointestinal symptoms and dietary information
- Metabolic markers (triglycerides, LDL, HDL, insulin, glucose, leptin, adiponectin)
- Immune markers (IL6)
- HIV-specific data (CD4+ and CD8+ cell counts, CD4+ nadir, viral load, etc)
- Gut microbiome (16S rRNA gene)

Data analysis:
- 16S rRNA gene sequencing analysis was performed using QIIME 2. Linear mixed effects (LME) modeling was used to address individual subject variation when looking for relationships and changes over time.

Results

Figure 1. Principal Coordinates Analysis (PCoA) of dietary components for individuals in an agrarian (left) and Western (right) diet. Euclidean distance matrix created from protein, fat, carbs, fiber, sodium, and sugar (all per 1000kcal). T1—sphere, T2—ring, and T3—cone. Large spheres are standard AD (left); standard WD (right).

Most subjects started on a WD and those placed onto an AD shifted toward an AD composition.

At baseline, IL6 was significantly elevated (6.7 pg/mL) in HIV+ individuals, and HIV- individuals high risk for HIV (8.3 pg/mL), compared to HIV- low risk individuals (3.1 pg/mL) (Wilcoxon tests, FDR-adjusted: q = 0.01 and q = 0.02, respectively).

Future Directions

- Use other immune markers as health outcome (Lipopolysaccharide (LPS)-binding protein (LBP) and c-reactive protein (CRP))
- Assess effect of MSM on our findings
- Explore enterotype classification and possible shifts from baseline
- Explore data imputation methods
- Develop machine learning model using longitudinal data for prediction of health benefit for individual at baseline using mixed effects random forests (MERFS) [5]

References


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