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# FOOD INSECURITY IS ASSOCIATED WITH INCREASED INFLAMMATION AMONG HIV-POSITIVE WOMEN

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# BACKGROUND: CHRONIC INFLAMMATION

- Chronic inflammation is associated with worse HIV clinical outcomes and non-HIV related comorbidities.<sup>1-3</sup>
- Limited research has considered how social and structural factors influence chronic inflammation among PLWH.

# BACKGROUND: FOOD INSECURITY

- **Food insecurity:** having limited or uncertain availability of nutritionally adequate and safe food, or the inability to procure food in socially acceptable ways<sup>4</sup>
- Food insecurity is associated with increased morbidity<sup>5,6</sup> and mortality<sup>7,8</sup> among PLWH.
  - Inflammation potential mechanism linking food insecurity to morbidity and mortality



# BACKGROUND: FOOD INSECURITY AND INFLAMMATION

- Potential pathways linking food insecurity and inflammation:
  - Poor HIV viral control
  - Nutritional pathway

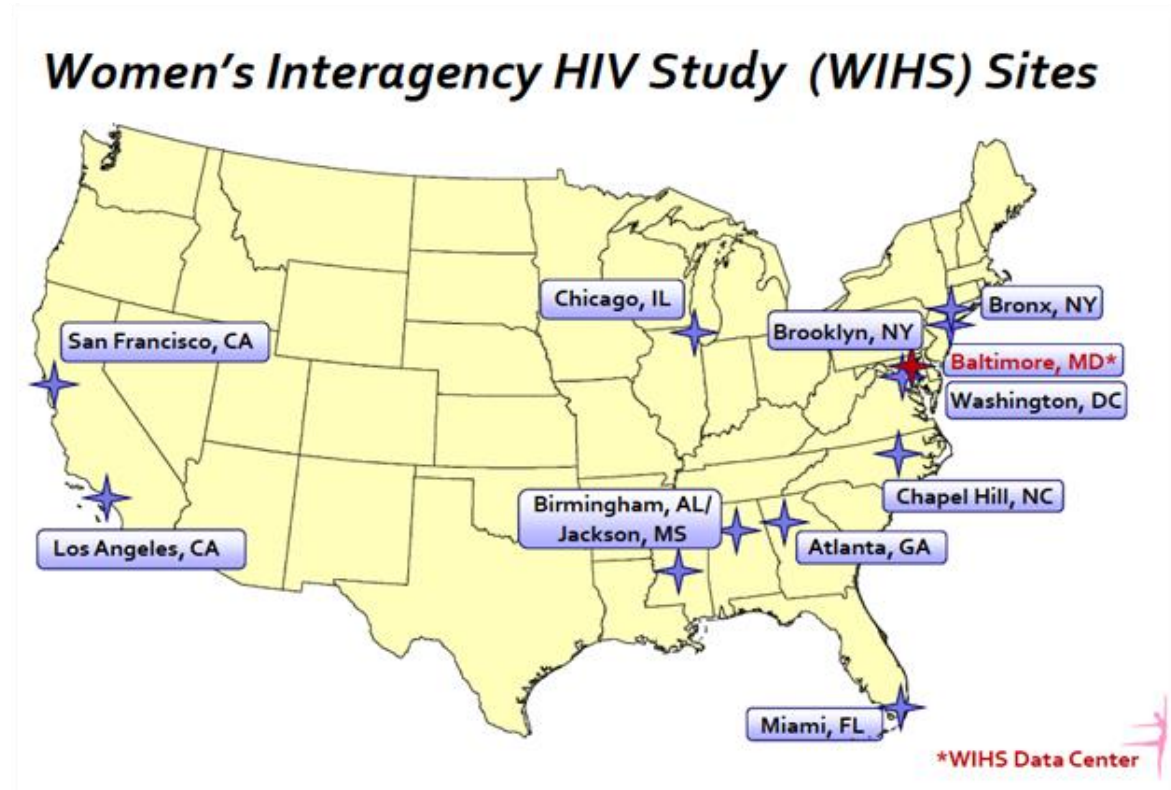


# STUDY AIMS

- **Aim 1:** Examine whether food insecurity is associated with higher levels of pro-inflammatory cytokines interleukin-6 (IL-6) and tumor necrosis factor 1 (TNFR1) among a sample of women living with HIV in the United States.
- **Aim 2:** Assess whether HIV viral control and nutritional pathways mediate the associations between food insecurity and the inflammatory markers of interest.

# THE WOMEN'S INTERAGENCY HIV STUDY (WIHS)

- 1994-present in 9 sites across the United States
- Participants recruited from range of settings:
  - HIV primary care clinics, HIV testing sites, hospital-based programs, drug rehabilitation programs, women's support groups, and referrals from enrolled participants



# METHODS: DESIGN & SAMPLE

- **Design:** Cross-sectional data collected from April-September 2015 from WHS participants
- **Sample:** 421 women living with HIV on antiretroviral therapy with available fasting blood and without diagnoses of comorbidities associated with high levels of inflammation (e.g., cancer, autoimmune diseases, etc.).

# METHODS: MEASURES

- **Outcomes:** Markers of immune inflammation, measured by pro-inflammatory cytokines IL-6 and TNFR1.
  - Log transformed
- **Independent variable:** Food insecurity measured by the validated 18-item U.S. Household Food Security Survey Module.<sup>4</sup>
  - Binary variable (any vs. no food insecurity)
- **Covariates:** Age at visit, education, race/ethnicity, income, and recent illicit substance use
- **Hypothesized mediators:** BMI, fat intake, log viral load and CD4



# METHODS: ANALYSIS

- Separate multivariable linear regression models were used to assess the association between food insecurity and IL-6 and TNFR1, adjusting for covariates.
- **Mediation analysis:** used the product method<sup>8</sup> to assess whether HIV viral load, CD4 count, BMI or intake of high fat foods mediated the relationship between food insecurity and the inflammatory markers
- **Sensitivity analysis:** Conducted adjusted analysis described above, stratified by HIV control ("controlled" HIV defined as virally suppressed and  $CD4 \geq 500$  cells/mm<sup>3</sup>).

# RESULTS

**Table 1. Background characteristics (n=421)**

| Characteristics                               | n (%)    |
|---|----------|
| Age, years, mean (SD)                         | 46 (9)   |
| Race  |          |
| Non-Hispanic white                            | 31 (7)   |
| Hispanic                                      | 46 (11)  |
| African American/black                        | 331 (79) |
| Other   | 12 (3)   |
| Annual household income                       |          |
| ≤\$12,000                                     | 211 (52) |
| \$12,001-\$24,000                             | 97 (24)  |
| ≥\$24,001                                     | 102 (25) |
| ≥ High school education                       | 298 (71) |
| Virally suppressed                            | 327 (79) |
| CD4 ≥500                                      | 292 (70) |
| Any food insecurity                           | 129 (31) |
| BMI,kg/m <sup>2</sup> , mean (SD)             | 33 (10)  |
| Intake of high-fat foods, servings, mean (SD) | 2 (2)    |
| Any illicit substance use since last visit    | 18 (4)   |

# RESULTS: FOOD INSECURITY AND IL-6

**Table 2. Adjusted associations between food insecurity and IL-6**

| Characteristics                          | Adjusted models                           | Adjusted models + viral load, BMI, and fat intake |
|--|---|---|
|  | Relative difference <sup>a</sup> (95% CI) | Relative difference <sup>a</sup> (95% CI)         |
|  | n=409                                     | n=395   |
|  | R-squared=0.07                            | R-squared=0.22                                    |
| Age at visit (per 10 years)              | 1.07 (0.99, 1.17)                         | 1.14 (1.05, 1.24) **                              |
| High school education or more            | 1.08 (0.92, 1.27)                         | 1.07 (0.92, 1.25)                                 |
| Race/ethnicity (Non-Hispanic white ref)  |   |   |
| Hispanic                                 | 1.21 (0.85, 1.71)                         | 1.27 (0.92, 1.75)                                 |
| Black/African American                   | 1.36 (1.03, 1.80) *                       | 1.24 (0.95, 1.61)                                 |
| Other                                    | 1.15 (0.70, 1.89)                         | 1.01 (0.62, 1.66)                                 |
| Annual household income (≤ \$12,000 ref) |   |   |
| \$12,001-\$24,000                        | 0.79 (0.66, 0.95) *                       | 0.80 (0.67, 0.95) **                              |
| ≥ \$24,001                               | 0.79 (0.66, 0.95) *                       | 0.82 (0.69, 0.98) *                               |
| Any food insecurity                      | 1.28 (1.09, 1.50) **                      | 1.24 (1.06, 1.44) **                              |
| Illicit substance use                    | 0.98 (0.68, 1.41)                         | 1.02 (0.72, 1.44)                                 |
| Viral load (log 10)                      | --  | 1.11 (1.02, 1.20) *                               |
| BMI (per 3kg/m <sup>2</sup> )            | --  | 1.09 (1.06, 1.11) ***                             |
| Fat intake (servings per day, per 3)     | --  | 1.18 (1.06, 1.32) **                              |

\*p<0.05; \*\*p<0.01; \*\*\*p<0.001

<sup>a</sup> The factors above are natural exponential “e” of the regression coefficients and are interpreted as multiplicative factors

# RESULTS: FOOD INSECURITY AND TNFR1

**Table 3. Adjusted associations between food insecurity and TNFR1**

| Characteristics                          | Adjusted models  | Adjusted models + viral load, BMI, and fat intake                    |
|--|--|--|
|  | Relative difference <sup>a</sup> (95% CI)<br>n=409<br>R-squared=0.07 | Relative difference <sup>a</sup> (95% CI)<br>n=395<br>R-squared=0.20 |
| Age at visit (per 10 years)              | 1.03 (0.99, 1.07)  | 1.06 (1.01, 1.10) **   |
| High school education or more            | 1.06 (0.98, 1.15)  | 1.06 (0.98, 1.14)  |
| Race/ethnicity (non-Hispanic white ref)  |  |  |
| Hispanic                                 | 0.77 (0.65, 0.92) **   | 0.78 (0.67, 0.92) **   |
| Black/African American                   | 0.84 (0.73, 0.96) *  | 0.81 (0.71, 0.92) **   |
| Other                                    | 0.78 (0.61, 0.99) *  | 0.76 (0.59, 0.96) *  |
| Annual household income (≤ \$12,000 ref) |  |  |
| \$12,001-\$24,000                        | 1.06 (0.97, 1.16)  | 1.08 (0.99, 1.17)  |
| ≥ \$24,001                               | 0.91 (0.84, 1.00)  | 0.93 (0.85, 1.01)  |
| Any food insecurity                      | 1.14 (1.06, 1.23) **   | 1.12 (1.04, 1.21) **   |
| Illicit substance use                    | 1.02 (0.86, 1.22)  | 1.03 (0.87, 1.22)  |
| Viral load (log 10)                      | --   | 1.07 (1.03, 1.11) **   |
| BMI (per 3kg/m <sup>2</sup> )            | --   | 1.04 (1.03, 1.05) ***  |
| Fat intake (servings per day, per 3)     | --   | 1.04 (0.98, 1.09)  |

\*p<0.05; \*\*p<0.01; \*\*\*p<0.001

<sup>a</sup> The factors above are natural exponential “e” of the regression coefficients and are interpreted as multiplicative factors

# RESULTS: SENSITIVITY ANALYSIS

**Table 4. Adjusted associations between food insecurity, IL-6 and TNFR1 among women with controlled HIV (N=167)**

| Characteristics                          | IL-6                                      | TNFR1                                     |
|--|---|---|
|  | Controlled HIV <sup>a</sup>               | Controlled HIV <sup>a</sup>               |
|  | Relative difference <sup>b</sup> (95% CI) | Relative difference <sup>b</sup> (95% CI) |
| Any Food Insecurity                      | 1.31 (1.04, 1.65) *                       | 1.21 (1.07, 1.38) **                      |
| Age at visit (per 10 years)              | 1.00 (0.88, 1.14)                         | 1.02 (0.95, 1.10)                         |
| High school education or more            | 1.12 (0.88, 1.41)                         | 1.09 (0.95, 1.24)                         |
| Race/ethnicity (white ref)               |   |   |
| Hispanic                                 | 1.23 (0.74, 2.04)                         | 0.78 (0.59, 1.04)                         |
| Black/African American                   | 1.24 (0.82, 1.88)                         | 0.83 (0.66, 1.04)                         |
| Other                                    | 0.62 (0.30, 1.31)                         | 0.66 (0.44, 1.00)                         |
| Annual household income (≤ \$12,000 ref) |   |   |
| \$12,001-\$24,000                        | 0.65 (0.48, 0.86) **                      | 1.19 (1.01, 1.39) *                       |
| ≥ \$24,001                               | 0.90 (0.69, 1.18)                         | 0.95 (0.82, 1.10)                         |
| Illicit substance use                    | 1.02 (0.63, 1.66)                         | 1.13 (0.86, 1.48)                         |

\*p<0.05; \*\*p<0.01; \*\*\*p<0.001

<sup>a</sup> HIV control defined as undetectable viral load and CD4 ≥ 500 cells/mm<sup>3</sup>

<sup>b</sup>The factors above are natural exponential “e” of the regression coefficients and are interpreted as multiplicative factors

# DISCUSSION

- Food insecurity is associated with elevations in markers of inflammation in HIV-infected women.
  - Inflammation may lie on pathway between food insecurity and morbidity and mortality among PLWH
- Viral load, CD4, BMI and intake of high-fat foods were not mediators
- Food insecurity is associated with inflammation regardless of HIV control.

# STRENGTHS & LIMITATIONS

## ■ Strengths

- Ethnically and geographically diverse cohort
- Relatively large sample size with immunological measures
- Excluded women with diagnoses of comorbidities associated with high levels of inflammation

## ■ Limitations

- Cross-sectional
- Limitations with measures of fat stores and fat intake
- Unable to assess the role of stress

# IMPLICATIONS

- Longitudinal research
- HIV programs should address food insecurity among PLWH to prevent negative health outcomes including inflammation.





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