Dehydration Status and Heat Related Symptoms in Florida Farmworkers

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Dean and Professor Nell Hodgson Woodruff School of Nursing
Emory University
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The “Year of Climate Change & Health”

"We're committed to making sure the nation knows about the effects of climate change on health. If anyone doesn't think this is a severe problem, they are fooling themselves." --APHA Executive Director Georges Benjamin, in the Washington Post
The Impacts of Climate Change on Human Health in the US

The Impacts of Climate Change on Human Health in the United States

A Scientific Assessment

U.S. Global Change Research Program
Climate Change and Health—Extreme Heat

Climate Drivers
- More frequent elevated temperatures
- Prolonged heat waves
- Seasonal timing of events

Environmental & Institutional Context
- City planning: Urban heat island effect
- Access to support services & resources (electricity, water, cooling centers)

Exposure Pathways
- Exposure to elevated temperatures (daily maximum, minimum, and mean)
- Combined impact of temperature, humidity, wind, & sunlight

Social & Behavioral Context
- Social isolation, poverty, and homelessness
- Access to & use of air conditioning
- Outdoor work, recreation, and commuting
- Appropriate heat prevention messaging
- Chronic illness, medication use, or personal, physical, & cognitive constraints

Health Outcomes
- Deaths, illness, hospital and emergency department visits
Estimated Deaths & Billion Dollar Losses from Extreme Events in the United States 2004–2013

- Heat Waves
- Tornadoes
- Hurricanes
- Floods
- Wind Storms
- Lightning
- Cold Waves
- Winter Storms

Billion Dollar Losses from Disasters (2004-2013)
- $392 Billion Hurricanes
- $78 Billion Heat Waves/Droughts
- $46 Billion Tornadoes/Severe Storms
- $30 Billion Flooding/Severe Storms
Third National Climate Assessment: Climate Change Impacts in the United States.
Vulnerable Populations

• Factors that Contribute to Exposure
  • Occupation
  • Time spent in risk-prone locations
  • Responses to extreme events
  • Socioeconomic status
  • Infrastructure conditions and access
  • Compromised mobility, cognitive function and other mental or behavioral factors
Pregnancy Health Among Florida Farmworkers

Aims

• Examine current perceptions of work hazards
• Assess extent of heat, ergonomic stress, and chemical exposures
• Develop health promotion education materials
• Disseminate results
Heat Related Illness Death

Pregnant Farmworker Dies After Being Denied Shade, Water; Family Calls for Action

Thursday, June 05, 2008
Associated Press

LODI, California — The death of a pregnant teenager pruning grape vines in scorching heat has outraged California's farmworking community and sparked calls for safety reforms as laborers prepare for the long summer harvest.

Authorities in California — the only state with a heat-illness standard — suspect Maria Isabel Vasquez Jimenez, a 17-year-old undocumented Mexican immigrant, collapsed last month because her farm labor contractor denied employees proper access to shade and water.

On Wednesday, 500 farmworkers and their advocates capped a poignant, four-day march to the statehouse demanding safer
Heat Stress: hot humid work environments
The Girasoles (Sunflower) Study
2014-2018

Centers for Disease Control and Prevention | National Institute for Occupational Safety and Health R01OH010657
Five Girasoles Study Recruitment Locations

• Apopka
• Pierson
• Immokalee
• Fellsmere
• Homestead
Farmworker dies after complaining of heat exhaustion on bus ride back to Immokalee

Monica Heredia, Naples Daily News

Local and federal authorities are investigating the death of a Haitian farmworker who died after complaining of heat exhaustion during a two-hour bus ride back to Immokalee from the tomato fields.

Jean Francois Alcime, 50, received water and ice before leaving the field Tuesday, but died in the bus. Alcime said he needed help, a co-worker, Louis Nenousse Decau, who was sitting next to him told Collier County deputies.

Decau told deputies he called the contractor and owner of the Gomez Harvesting bus, Adelio Trevino, and he told her Alcime wasn’t feeling well.

Decau told deputies Trevino said Alcime should rest on the bus and that they should call the paramedics when the bus returned to Immokalee if he didn’t feel better.

But when the bus arrived in Immokalee and Decau tried to wake up Alcime, he wasn’t breathing, according to the Collier Sheriff’s Office report.

Trevino, who was contracted by McCollum Farms out of Palmetto to have the crew work there, told deputies Alcime appeared tired and was stumbling earlier that day. She said she gave him water and an ammonia inhalant, and she put ice on his neck because he was complaining of heat exhaustion.

Trevino told deputies she believed Alcime was better after assuaging him, and she had him go on the bus back to Immokalee. She followed the bus in another vehicle. She told the deputies that when the bus arrived in Immokalee, at about 7 p.m. Tuesday, the workers told the driver that Alcime appeared to be sleeping on the ride, but that when they attempted to wake him, he was not responding or breathing.

The driver told Trevino and when she attempted to wake Alcime, she saw he wasn’t breathing.

NO SUNSCREEN REQUIRED

Come see our sea creatures inside the Dalton Discovery Center.

TOP VIDEOS
Comprehensive Heat Stress Monitoring

Actigraph monitor records physical activity and amount of movement.

Heart rate monitor measures heart beats during work.

Cortemp monitor records the internal temperatures from the pill.

Home monitor records the overnight temperatures from the home.

iButton records the temperature and humidity at your workplace.
### Demographics of Florida Farmworkers (n= 192); 2015-2016

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n (%) or mean ± sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>38.0 ± 8.2</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>76 (40%)</td>
</tr>
<tr>
<td>Female</td>
<td>116 (60%)</td>
</tr>
<tr>
<td><strong>Nationality</strong></td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>124 (65%)</td>
</tr>
<tr>
<td>Guatemala</td>
<td>34 (16%)</td>
</tr>
<tr>
<td>Haiti</td>
<td>26 (13%)</td>
</tr>
<tr>
<td>United States</td>
<td>3 (2%)</td>
</tr>
<tr>
<td>Other</td>
<td>8 (4%)</td>
</tr>
<tr>
<td><strong>Years of education</strong></td>
<td>6.5 ± 3.5</td>
</tr>
<tr>
<td><strong>BMI</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>27.9 ± 4.2</td>
</tr>
<tr>
<td>Female</td>
<td>29.2 ± 4.5</td>
</tr>
</tbody>
</table>
### Work Characteristics of Florida Farmworkers (n= 192); 2015-2016

<table>
<thead>
<tr>
<th>Work Characteristics</th>
<th>n (%) or mean ± sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years worked in agriculture</td>
<td>12.0 ± 7.8</td>
</tr>
<tr>
<td>Hours worked per day</td>
<td>7.5 ± 1.5</td>
</tr>
<tr>
<td>Primary work type</td>
<td></td>
</tr>
<tr>
<td>Nursery</td>
<td>59 (31%)</td>
</tr>
<tr>
<td>Fernery</td>
<td>67 (35%)</td>
</tr>
<tr>
<td>Crop</td>
<td>66 (34%)</td>
</tr>
<tr>
<td>Drink more of beverage at work during hot and humid weather</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>188 (98%)</td>
</tr>
<tr>
<td>Sports drinks</td>
<td>132 (69%)</td>
</tr>
<tr>
<td>Soda</td>
<td>96 (50%)</td>
</tr>
<tr>
<td>Juice</td>
<td>74 (39%)</td>
</tr>
<tr>
<td>Energy drinks</td>
<td>31 (16%)</td>
</tr>
<tr>
<td>Coffee</td>
<td>18 (9%)</td>
</tr>
<tr>
<td>Alcohol</td>
<td>4 (2%)</td>
</tr>
</tbody>
</table>
Environmental Characteristics on Data Collection Days Across Three Florida Communities 2015-2016

<table>
<thead>
<tr>
<th>Environmental Characteristics</th>
<th>n (%) or mean ± sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature (°F)</td>
<td>84.4 ± 3.3</td>
</tr>
<tr>
<td>Relative Humidity (%)</td>
<td>73.9 ± 9.6</td>
</tr>
<tr>
<td>Mean Heat Index</td>
<td>91.8 ± 5.9</td>
</tr>
</tbody>
</table>
Heat-related Illness: Symptoms

Most Common Symptoms

- Excessive Sweating: 64%
- Headache: 56%
- Dizziness: 32%
- Muscle Cramps: 30%
- Nausea or Vomiting: 21%
- Confusion: 15%
- Fainting: 10%
Figure 1. Frequencies of symptoms reported by farmworkers for previous workweek and during the monitored workweek. (a) By type of HRI symptom. (b) Distribution of 0, 1-2, or 3 or more symptoms.
Body Temperature & Heart Rate - Summer
Body Temperature & Heart Rate - Winter

![Graph showing changes in core temperature and heart rate over time, with work start and stop markers. The graph indicates an increase in both temperature and heart rate throughout the day, with a peak around 16:00.](image-url)
Core Body Temperature

PHASE 1:
This graph shows several issues that commonly arise in our data:

A- Bouncing ball effect
B- Rapid decline/recovery
C- Extreme values
D- Gaps

△ = observation; □ = estimated curve
Core Body Temperature

PHASE 2:

Observations from multiple participants for each 30 second time point create a median core temperature estimate.

A smooth curve is generated by these point estimates.
Core Body Temperature

**PHASE 3:**

Comparison of median core temperatures for each 30 second time point during the workday.

Work hours 5-7 have the most occurrences when the difference between Fernery and Nursery core temperatures are significant.
Dehydration Measures

• Urine Specific Gravity
  • Measure of solute concentration in urine
    • Comparison of water and urine density
    • Measure of kidney function and hydration status
    • USG ≥ 1.020 hypohydrated
    • 1.030 > clinically dehydrated

• Serum Osmolality
  • Measure of chemicals dissolved in serum
    • Na\(^+\), Cl\(^-\), Bicarbonate, Proteins, Sugars
    • Increases with dehydration
    • 275 to 295 mOsm/kg
    • > 296 dehydrated
Dehydration levels by urine specific gravity
Dehydration levels by serum osmolality
## Hydration Status among Florida farmworkers; 2015-2016

<table>
<thead>
<tr>
<th>Biomarker</th>
<th>Before Work(^1) (n = 190(^2))</th>
<th>After Work(^1) (n=192)</th>
<th>P value(^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USG, mean</td>
<td>1.019 ± 0.005</td>
<td>1.024 ± 0.006</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>USG ≥ 1.020</td>
<td>53%</td>
<td>77%</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>USG &gt; 1.030</td>
<td>5%</td>
<td>15%</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Serum Osmolality, mean</td>
<td>296.7 ± 3.3</td>
<td>297.1 ± 4.1</td>
<td>.02</td>
</tr>
<tr>
<td>Serum Osm &gt; 296</td>
<td>54%</td>
<td>53%</td>
<td>.9</td>
</tr>
</tbody>
</table>

\(^1\) n participants for day 1 was n=192, day 2 was n=188 and day 3 was n=175  
\(^2\) based on 555 observations before work and 525 observations after work  
\(^3\) adjusted for number of days worked
Kidney Function Markers among Florida farmworkers; 2015-2016

<table>
<thead>
<tr>
<th>Biomarker</th>
<th>Before Work$^1$ (n = 190$^2$)</th>
<th>After Work$^1$ (n=192)</th>
<th>P value$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum Creatinine, mean</td>
<td>0.70 ± 0.21</td>
<td>0.81 ± 0.22</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>eGFR, mean</td>
<td>114.6 ± 13.4</td>
<td>104.3 ± 16.5</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>eGFR &lt;90</td>
<td>5%</td>
<td>24%</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>BUN, mean</td>
<td>14.6 ± 4.2</td>
<td>15.8 ± 4.5</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Serum Potassium, mean</td>
<td>4.4 ± 0.3</td>
<td>4.2 ± 0.4</td>
<td>.003</td>
</tr>
<tr>
<td>Serum Sodium, mean</td>
<td>140.9 ± 1.4</td>
<td>141.1 ± 1.7</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

$^1$n participants for day 1 was n=192, day 2 was n=188 and day 3 was n=175

$^2$based on 555 observations before work and 525 observations after work

$^3$adjusted for number of days worked
Girasoles Community Engagement

• Dissemination of results to community
• Outreach to provide care for participants
• Training promotoras
• Community Advisory Board
• Health screenings
• Clinician handouts
• Focus groups
Participants Health Education
- Body composition information (BMI, body fat)
- Blood pressure reading
- Approximate highest internal temperature
- On-site blood analysis reports

Information Addresses
- Heat prevention practices
- Warning signs
- Recommended ranges for BMI and blood sugar
**Indice de masa corporal**

<p>| | |</p>
<table>
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<th></th>
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<tbody>
<tr>
<td>&lt;18.5</td>
<td>Bajo de peso</td>
</tr>
<tr>
<td>18.5-24.9</td>
<td>Normal</td>
</tr>
<tr>
<td>25-29.9</td>
<td>Sobrepeso</td>
</tr>
<tr>
<td>30+</td>
<td>Obesidad</td>
</tr>
</tbody>
</table>

La diabetes es una enfermedad en la que el exceso de azúcar en el cuerpo conduce a problemas de salud. Azúcar en la sangre recomendada <200

**Control y Prevención**

- Mantenga un peso (IMC) normal
- Perder 7% del peso corporal (For BMI > 25)
- Evitar los alimentos azucarados
- Ejercitar 30 minutos 5 días a la semana
- Consulte a su médico si experimenta síntomas de insolución

**Qué hacer**

- Trasládese a una zona más fresca o con sombra
- Beber agua o bebidas deportivas
- Ventile y aplique agua fría al cuerpo

**Endéks Mas Kò**

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<tbody>
<tr>
<td>&lt;18.5</td>
<td>Még</td>
</tr>
<tr>
<td>18.5 - 24.9</td>
<td>Nómal</td>
</tr>
<tr>
<td>25 - 29.9</td>
<td>Twò gwo</td>
</tr>
<tr>
<td>30+</td>
<td>obèz</td>
</tr>
</tbody>
</table>

El estrés por calor señales de advertencia:

- Sudor excesivo
- Respiración rápida
- Debilidad
- Mareos
- Fatiga
- Náuseas
- Vómitos
- Calambres

__Swe anpil__
__Respire rapid__
__Feblès__
__Vättij__
__Fatig__
__Kè plen Vomisman__

**Kontwòl ak prevansyon**

- Rete nan nòmal EMK
- Pèdi 7% nan pwa kò
- Evite manje ki gen sik
- Egzèse 30 minit senk jou nan yon semen
- Konsite doktè ou si experimente sentòm

**Kisa pou fe**

- deplase nan pi fre, zòn fonse chita
- bwè dlo oswa espò bwè
- fanatik ak aplike dlo fre nan kò
Farmworker Community Demographics
- Age
- Gender
- Race/Ethnicity

Farmworker Risk Factors
- BMI
- Blood pressure
- Serum analysis
- Max core temperature during workday
- Average dehydration levels
- Reported HRI symptoms
Participant Referrals In Apopka Summer 2016

- Elevated fasting glucose: 45 (37%)
- Elevated blood pressure: 22
- Low hemoglobin: 4
- Suspected urinary tract infection: 4
- Elevated BUN: 2
- Elevated creatinine: 2
- Suspected nephrolithiasis: 2

Percent Referred
Future Directions

• Interventions, interventions, interventions...
• Mesoamerican Nephropathy
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  • Jeannie Economos
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  • NIOSH R21 OH009830-01
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- Campbell, K. The association of skin rashes with work environment, personal protective equipment and hygiene practices in female farmworkers. *AAOHN Workplace Health & Safety. Accepted*.


Appendix
Serum creatinine

• 31% of participants had at least one workday with serum creatinine above sex-specific limits OR an increase of $\geq 0.3$ mg/dL on at least one workday

• Sex specific limits:
  • Males: $>1.3$ mg/dL
  • Females: $>1.1$ mg/dL
Acute Kidney Injury (AKI)

- Kidney Disease Improving Global Health Outcomes (KDIGO) criteria is based on serum creatinine change

<table>
<thead>
<tr>
<th>AKI present</th>
<th>Increase of post-shift serum creatinine by at least 0.3 mg/dL OR ≥ 1.5 times the pre-shift creatinine</th>
</tr>
</thead>
<tbody>
<tr>
<td>AKI stage 1</td>
<td>≥ 0.3 mg/dL increase in serum creatinine OR 1.5 to 1.9 times the pre-shift creatinine</td>
</tr>
<tr>
<td>AKI stage 2</td>
<td>2.0 to 2.9 times the pre-shift creatinine</td>
</tr>
<tr>
<td>AKI stage 3</td>
<td>≥ 3.0 times the pre-shift creatinine</td>
</tr>
</tbody>
</table>
AKI in Girasoles

Presence of AKI:
• 33% of participants had the criteria indicating AKI on at least one workday
  • 28% on one workday
  • 4% on two workdays
  • 1% on three workdays

Stages of AKI:
• 26% had stage 1 AKI on at least one workday; 3% on two; 0.5% on three
• 3% had stage 2 AKI on at least one workday
• 0.5% had stage 3 AKI on at least one workday
# Normal ranges/cutoff value for hydration and kidney markers

<table>
<thead>
<tr>
<th>MARKER</th>
<th>Normal Range/Cutoff value for Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydration markers</strong></td>
<td></td>
</tr>
<tr>
<td>Urine specific gravity (USG)</td>
<td>USG &lt;1.015: euhydrated</td>
</tr>
<tr>
<td>Serum osmolality</td>
<td>275-295 mOsm/kg</td>
</tr>
<tr>
<td><strong>Kidney function markers</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Serum creatinine            | Males: <1.1 mg/dL  
Females: <1.3 mg/dL                         |
| Estimated glomerular filtration rate (eGFR)| >90 ml/min/1.73m²                     |
| Blood urea nitrogen (BUN)   | 10-20 mg/dL                                   |
| Serum potassium             | 3.5 – 5.2 mEq/L or 3.5 – 5.2 mmol/L           |
| Serum sodium                | 136 – 145 mEq/L                               |