

# Risk of heat related illness in Latino agricultural workers: Work exposures and increase in core body temperature

California Heat Illness Prevention Study (CHIPS)

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**I declare no conflict of interest**



# California Heat Illness Prevention Study (CHIPS): Basic Study Aims

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- 1] Quantify heat strain risk of farmworkers throughout California. Assess hydration, core body temp, heart rate, work load and environmental conditions for different crop and tasks.
- 2] Examine socio-cultural perspective of Heat Related Illness using focus groups and key interviews.

Our goal is to combine this information and create improved heat illness prevention strategies for farmers and their hired farm workers



# Methods:

## California Heat Illness Prevention Study

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Convenience sample: Summer 1-day participation for farmworkers

**Core Body Temperature:** Measured real-time by ingestible sensor – per minute

**Hydration:** Pre-and post shift body weight (in base layer of clothing). Osmolality (serum) and drinking volumes / frequencies (questionnaire).

**Kidney function:** Post-pre shift creatinine

**Work rate:** Measured real-time by accelerometer and heart-rate monitor – per minute

**Environmental conditions:** Personal data logger, weather stations – portable (Quest), stationary (HOBO) and closest CIMIS (irrigation district weather station)/ airport. (Per minute)

**Questionnaire (Pre-Post Shift):** Worker demographics, health, knowledge, agricultural and heat illness history, current day experiences, etc.



# Risk Factors for HRI

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Environmental temperature & humidity are drivers of HRI risk

Modifiable risk factors are:

- Acclimatization
- Hydration rates and volumes at and before work
- Work rate (and rest period frequency) and work incentives
- Clothing
- Shift length or daylight period worked

Personal risk factors which may not be modifiable are:

- Illnesses and medications that predispose workers to elevated CBT
- Increasing age
- Possibly obesity
- Housing if it doesn't allow sufficient cooling for sleep
- Gender

# CHIPS Field Study: 2014,15



2014 facilities,  
(n=15)



# Associations with Core Body Temperature (CBT)

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We calculated both simple and multi-variable associations with the core (intestinal) temperature, monitored and recorded at 1-minute intervals.

## Outcome

- CBT increase  $\geq 1.5^{\circ}\text{C}$

## Covariates

- Age, BMI, gender, mean work activity (cpm), median WBGT, wage type, dehydration ( $\geq 1.5\%$  weight loss over shift), clothing



# Results

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- Study conducted over 2 summers: 2014 & 2015
- 587 participant workers monitored for one day each
- 30 different farms / Farm Labor Contractors (FLC's) throughout CA
  - 496 farmworkers with sufficient data to include in final analyses

# Selected characteristics

Characteristic N=318	Men n=236 (74%)	Women n=82 (26%)	Difference
Age years, mean (SD)	37.5 (12.3)	37.1 (9.0)	0.77
Clothing score	4.5 (1.4)	5.7 (2.0)	<b>&lt;0.001</b>
Pay type			
Piece-rate	65 (28%)	20 (24%)	0.58
Hourly	171 (72%)	62 (76%)	
BMI			
Healthy, 18.5 – 25	60 (25%)	10 (12%)	<b>0.04</b>
Overweight, 25 – 30	96 (41%)	37 (45%)	
Obese, 30+	80 (34%)	35 (43%)	

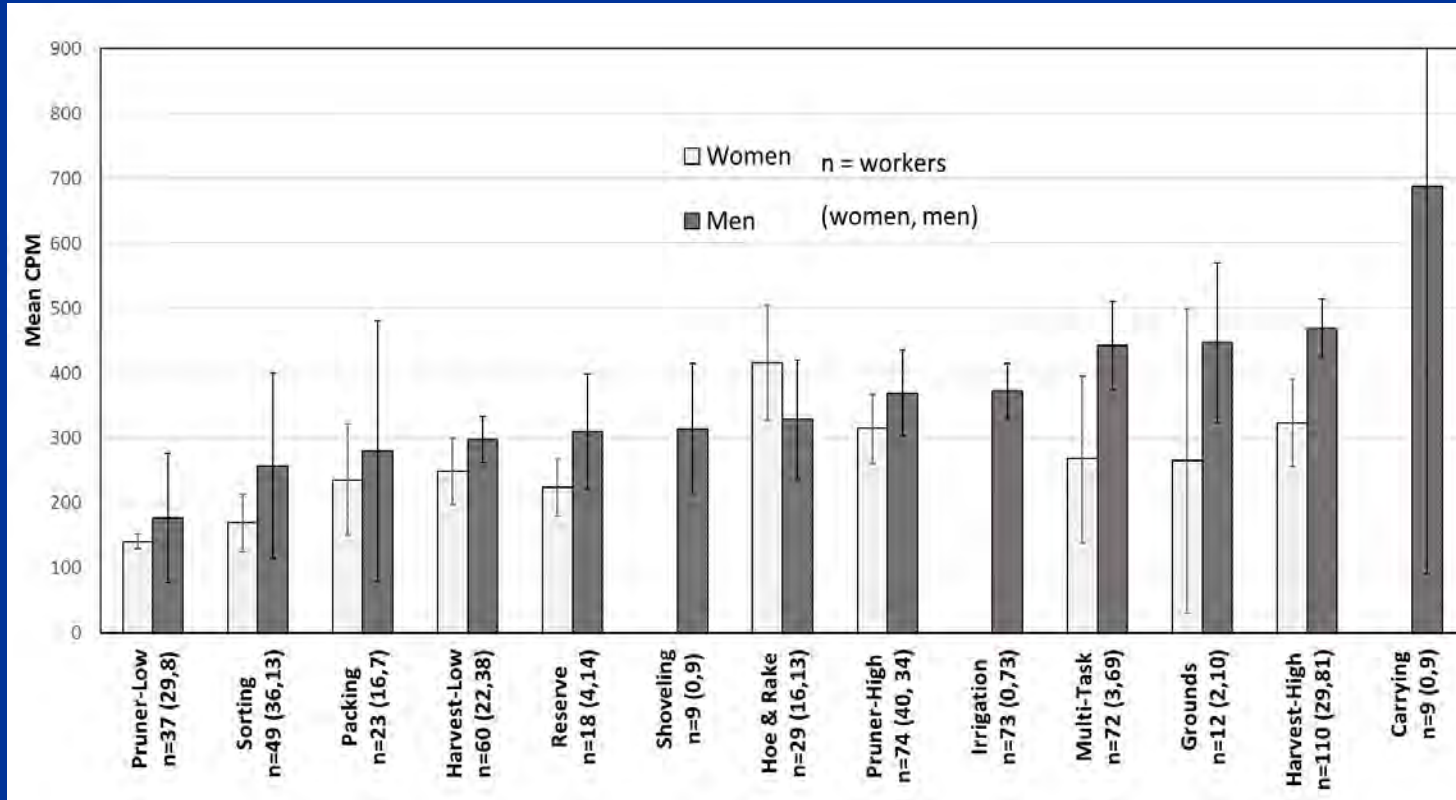
# Work Experiences

<b>Characteristic</b> N=7330 quarter hours Mean (SD)	<b>Men</b> n=5413 (74%)	<b>Women</b> n=1917 (26%)	<b>Difference</b>
Activity level*	475.5 (403.2)	388.1 (401.5)	<b>&lt;0.001</b>
WBGT**	25.3 (4.6)	25.3 (4.5)	0.66

\* Activity level = counts per minute, averaged over 15 minute periods

\*\* WBGT of previous quarter hour

# Common Tasks and their Work Rate by Gender



# Physiological measurements by gender CHIPS participants, 2014-5

Characteristic	Total (587) % or mean (SD)	Males % or mean (95 CI)	Females % or mean (95 CI)	Δ Sexes (P-value)
†Max Core Body Temp °C [Range] °C	38.0 (0.4)	38.0 (37.9 – 38.1) [36.6 – 39.8]	38.0 (37.9 – 38.0) [36.9 – 39.4]	0.800
<b>Max Core Temp ≥ 38.5 °C</b>	6.9 %	9.5%	2.2%	<b>0.002</b>
<b>Lost Weight over shift</b>	73.8 %	78.2%	34.7%	<b>0.0008</b>
<b>Lost &gt; 1.5% weight</b>	11.9 %	16.5 %	3.0 %	<b>&lt;0.0001</b>
<b>Any mOsm increase</b>	60.0 %	60.9 %	56.7 %	0.336
<b>Δ mOsm increase &gt;3 units over shift</b>	37.6 %	40.2 %	32.6 %	0.083
<b>*Drank &gt; 1 gallon water today</b>	22.8 %	29.1 %	10.5 %	<b>&lt;0.0001</b>
<b>BMI</b>	29.1 (4.6)	28.8 (28.3 – 29.2)	29.7 (29.1 – 30.4)	<b>0.018</b>

# Multivariable Linear Regression of Work Characteristics and Core Body Temperature

	Parameter Estimate	95% CI	Standardized Estimate*	95% CI	P-value
Female	0.11	(-0.01, 0.25)	0.12	(-0.01, 0.2)	0.08
Age (years)	-0.0007	(-0.005, 0.004)	-0.018	(-0.14, 0.1)	0.75
Dehydration (1 % weight loss)	0.08	(-0.05, 0.21)	0.07	(-0.04, 0.2)	0.22
<b>WBGT (°C)</b>	0.03	(0.017, 0.05)	0.25	(0.13, 0.37)	<b>&lt;0.0001</b>
<b>Activity level (per 1,000 cpm)</b>	0.6	(0.4, 0.9)	0.33	(0.21, 0.45)	<b>&lt;0.0001</b>
Clothing Insulation Heat Gain (Watts)	-0.00002	(-0.004, 0.004)	-0.0005	(-0.12, 0.12)	0.99
Head Gear Insulation Heat Gain (Watts)	0.001	(-0.006, 0.008)	0.02	(-0.1, 0.2)	0.71

# Elevated Body Temperature

## Summary of Associations

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- The environmental temperature and work rate are reliably associated with elevated CBT.
- In addition associations with  $CBT \geq 38.5^{\circ}C$  included piece rate work (if male), and shift length.
- Risk of HRI as measured by an increased body temperature  $\geq 1.5^{\circ}C$ , included only one woman. Environmental temperature, work rate, being male, of older age and experiencing  $\geq 1.5\%$  dehydration but not piece rate or shift length were associated risk factors.
- About 6-7% of study workers were at risk of HRI as defined.

# Field Study Conclusions

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- All farms studied complied with Cal/OSHA regulations; still about 7% workers at risk of HRI (as indicated by CBT).
- The environmental temperature and work rate are major risk factors for elevated HRI. Men, especially if they work piece rate are at higher risk. Dehydration (>1.5% loss of body weight) had a more ambivalent role.
- Clothing choice and work rate contribute to dehydration, and men are more likely to be dehydrated, despite drinking more than women. About 16% of men were dehydrated (3% of women).

A significant proportion of California farmworkers are still at risk of HRI, despite required yearly training and field resources (shade, water). Even those exhibiting knowledge often do not translate it into self-protective actions.



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Supported by:

NIOSH Grants

OH 007550

OH 010243





Thank you!



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