

Medical Requirements and Reliability of Workers Engaged in Demilitarization Protective Ensemble Operations - Heat Injury Prevention in Chemical Agent Workers



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Assembled Chemical Weapons Alternatives

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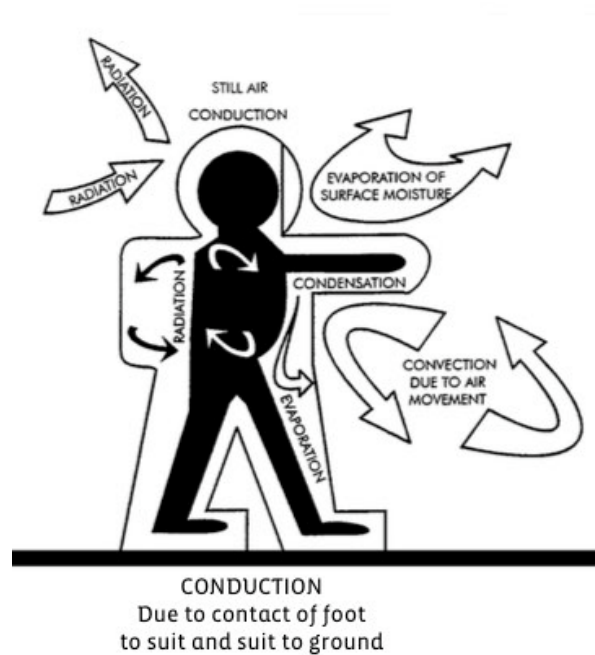
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Terms



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- Heat stress—total heat load put on the body from both internal and environment sources
- Heat strain—health effects to the body from heat stress





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Hypothesis – Question of Concern



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- Are controls appropriate for managing heat stress at Pueblo Chemical Agent-Destruction Pilot Plant training facility?
 - Compare with national recognized guidelines
 - Sample from medical monitoring interface data
 - Perform statistical analysis
- Can pre-entry data predict heat strain?



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Sampling and Data



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- Every fourth student completing toxic area training (23 total)
- Remove personally identifiable information
- Demilitarization Protective Ensemble entries (101 total)
- Factors, pre-entry screening variables
 - Pre-entry urine specific gravity (< 1.028)
 - Pre- ($< 140/91$) and post-entry blood pressure
 - Pre- (< 22 breaths/min) and post-entry respiratory rate
 - Pre- ($< 99^{\circ}\text{F}$) and post-entry temperature
 - Pre- and post-entry weight
 - Pre- (< 101 beats/min), during-, and post-entry heart rate



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Heart Rate During Entry



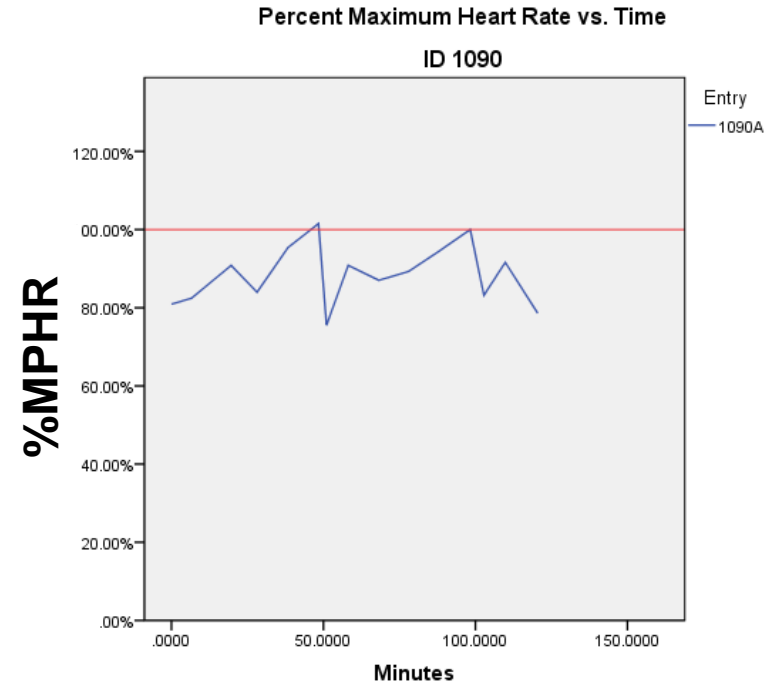
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- Maximum Heart Rate is highest heart rate during an entry
- Maximum Permissible Heart Rate (MPHR)

$$\text{MPHR} = 180 - \text{age}$$
where *age* is in years.

- Example chart of % MPHR Rate versus Time of Entry
 - Crossing red line indicates exceeding Maximum Predicted Heart Rate

Percent MPHR vs. Time of Entry





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Statistical analysis



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- Separate into two groups

Entries where Maximum Permissible Heart Rate was not exceeded

Entries where Maximum Permissible Heart Rate was exceeded

- Compare factors for two groups
 - Difference in averages
- Correlation of factors with highest percent of maximum heart rate during entry
- Significance level of $P = 0.05$
 - Probability of obtaining observed results by chance is less than 5%



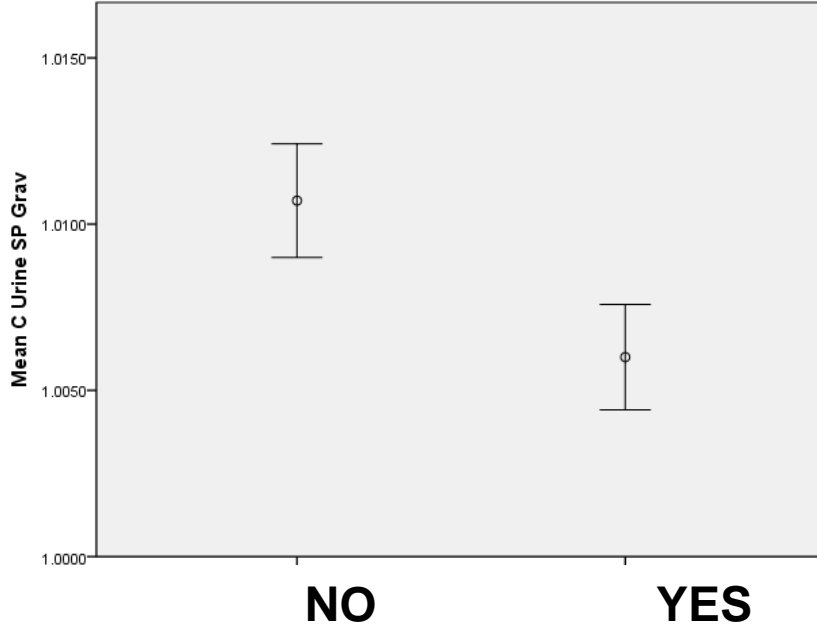
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Results: Urine specific gravity



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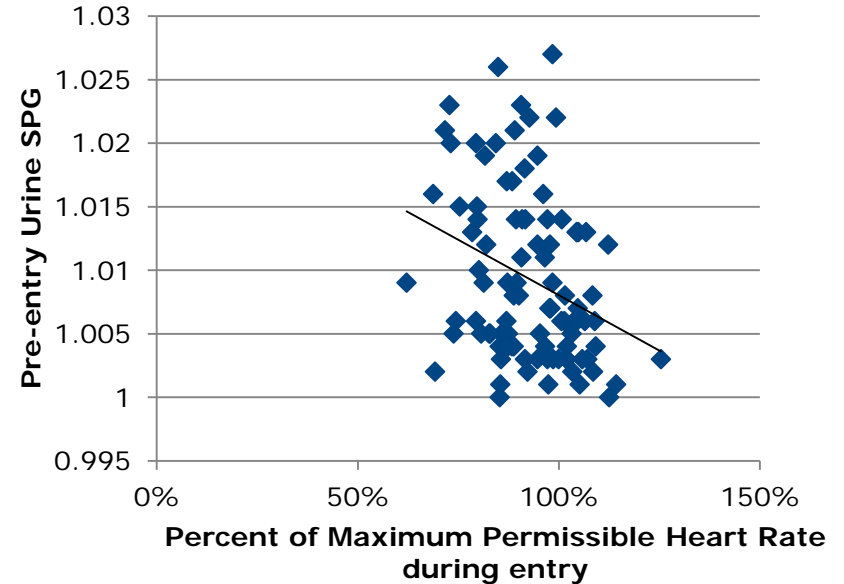
Average Urine Specific Gravity higher for entries that did not exceed Maximum Permissible Heart Rate than entrants who did exceed Maximum Permissible Heart Rate



Maximum permissible heart rate reached? (Error bars 95% confidence interval)

Urine Specific Gravity correlated with percent Maximum Permissible Heart Rate

Pre-entry Urine Specific Gravity vs. % Maximum Permissible Heart Rate





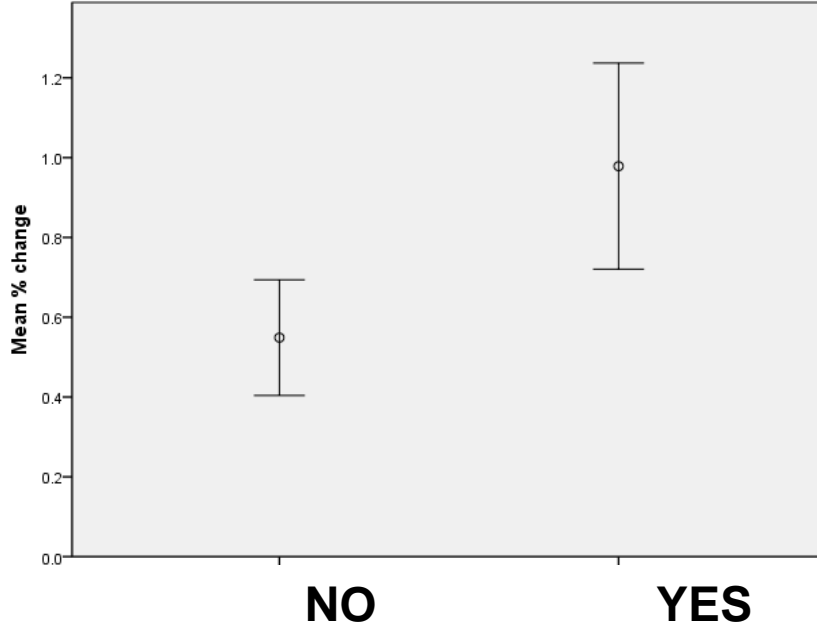
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Results: Percent change in weight



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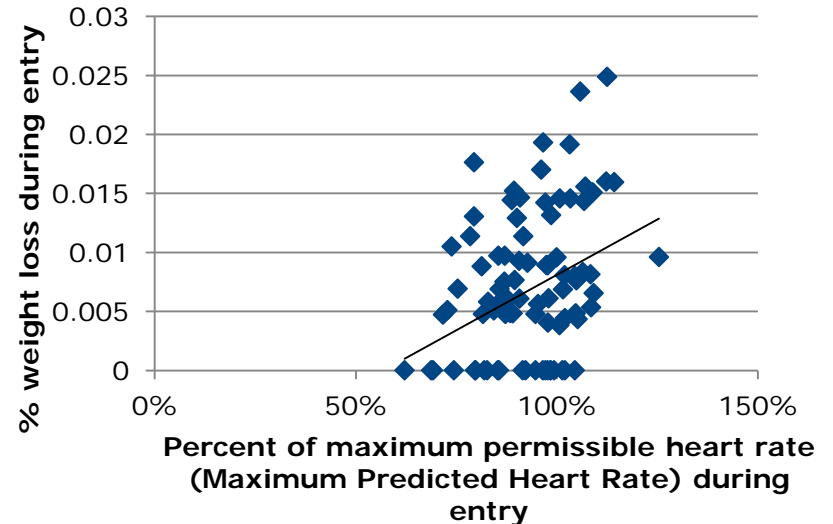
Percent change in weight greater for entries that exceeded Maximum Predicted Heart Rate than those who did not exceed Maximum Predicted Heart Rate



Maximum permissible heart rate reached? (Error bars 95% confidence interval)

Percent weight loss during entry correlates with % Maximum Predicted Heart Rate

Percent weight loss during entry vs. % Maximum Predicted Heart Rate





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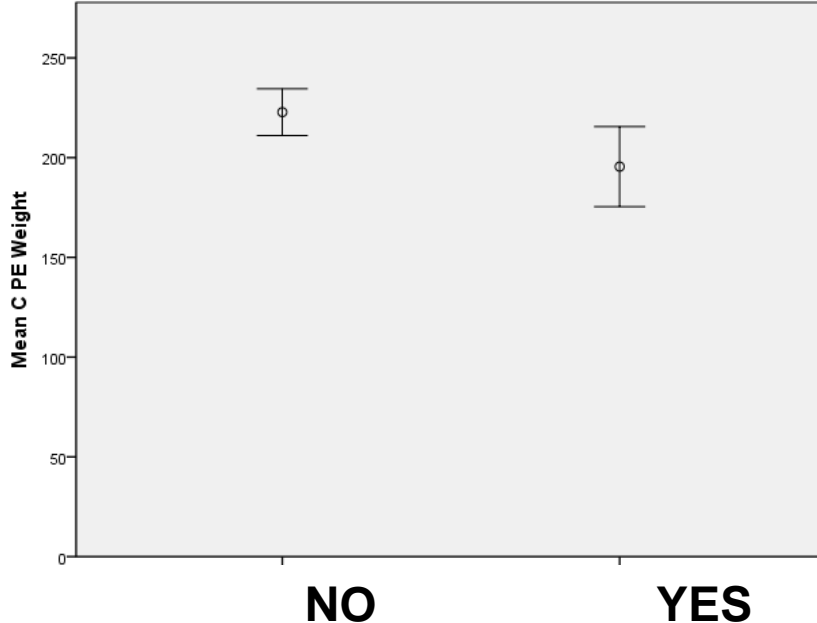
Results: Pre-entry weight



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Entries that did not exceed Maximum Predicted Heart Rate had higher average weight than those who exceeded Maximum Predicted Heart Rate

Correlation was not significant.



Maximum permissible heart rate reached? (Error bars 95% confidence interval)



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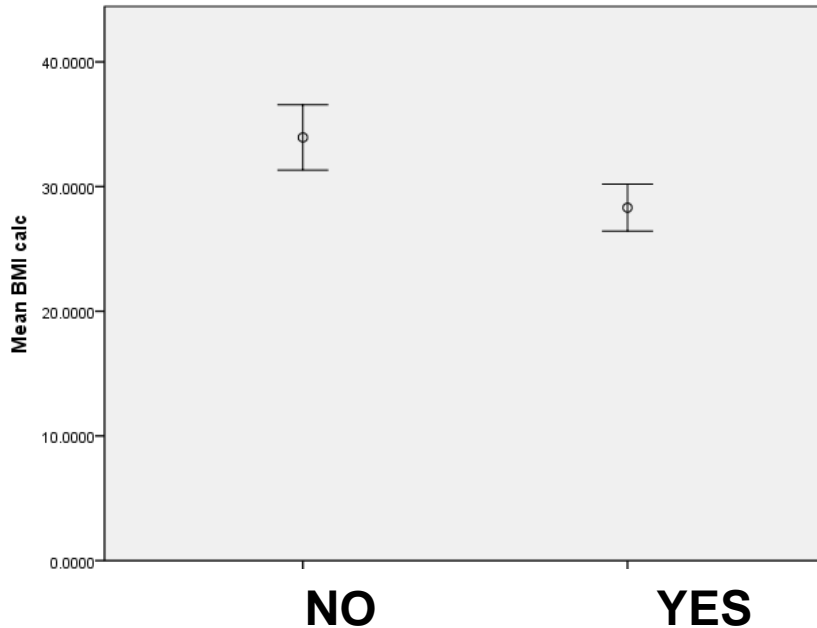
Results: Body Mass Index



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Correlation was not significant

Entries that did not exceed Maximum Predicted Heart Rate had higher Body Mass Index than those who exceeded Maximum Predicted Heart Rate



Maximum permissible heart rate reached? (Error bars 95% confidence interval)

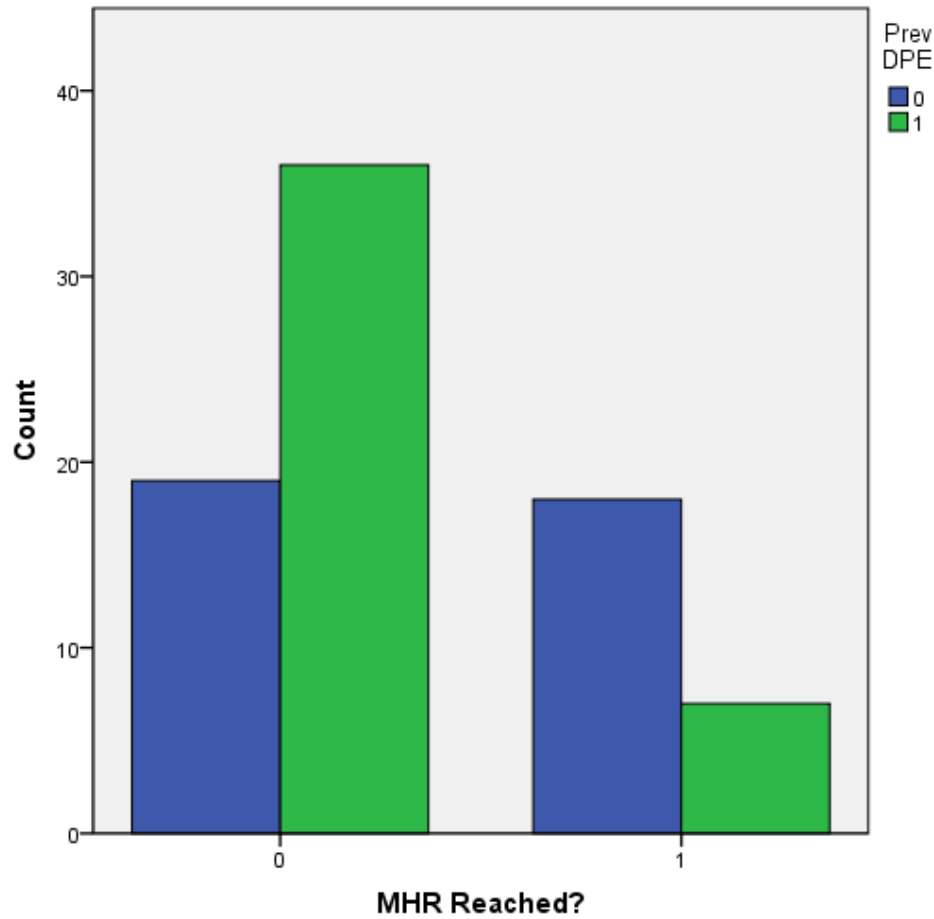


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Results: Prior Demilitarization Protective Ensemble Experience



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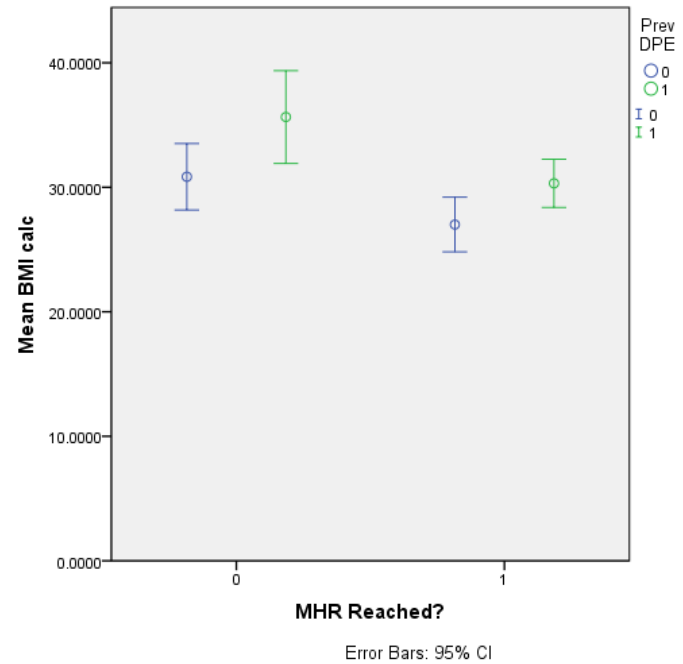
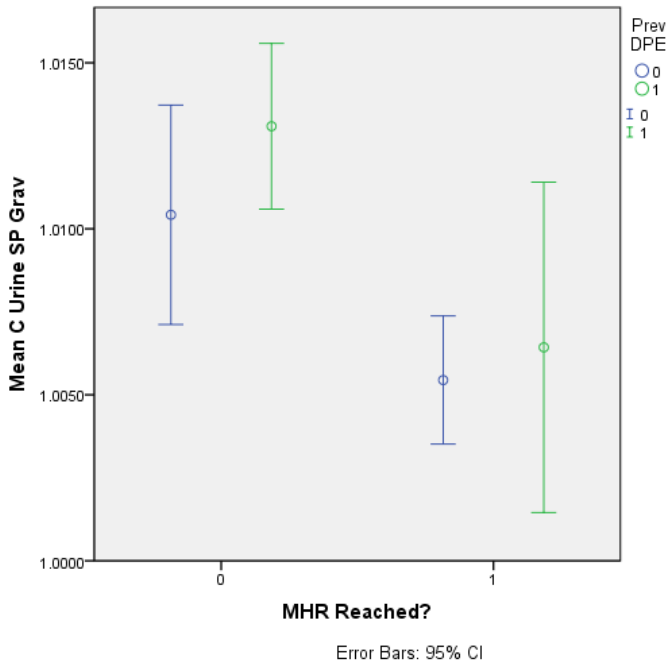


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Results: Urine Specific Gravity and Body Mass Index Stratified by Prior Demilitarization Protective Ensemble Experience



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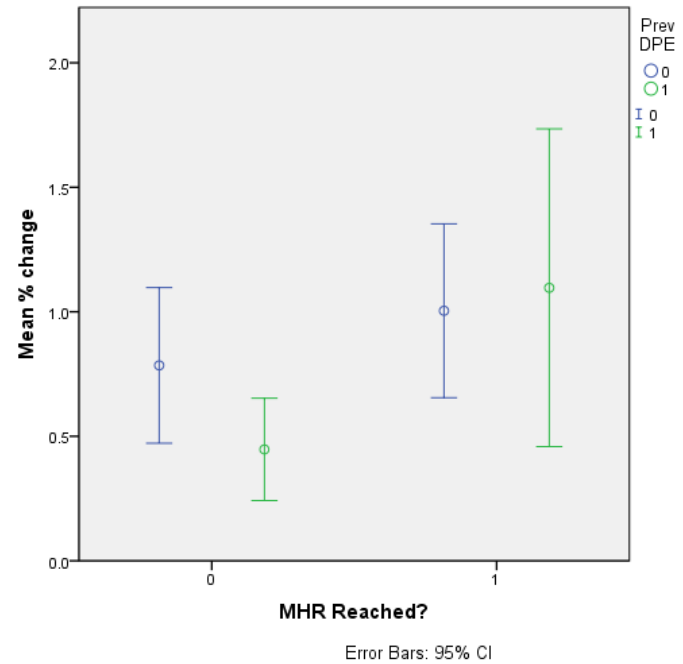
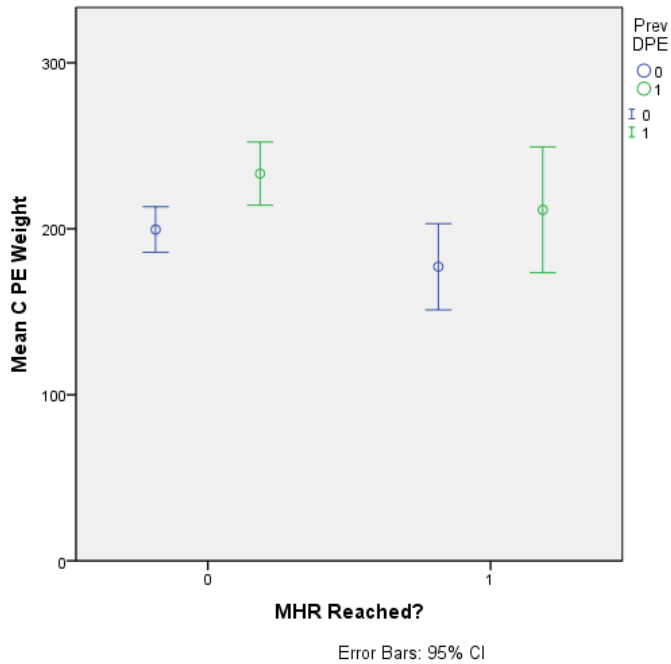


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Results: Pre-entry weight and % Change in weight Stratified by Prior Demilitarization Protective Ensemble Experience



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Results



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- Difference in means between entries who did not exceed Maximum Permissible Heart Rate and those that did and correlations with % Maximum Permissible Heart Rate was not significant for
 - Temperature
 - Respiratory rate
 - Systolic blood pressure
 - Diastolic blood pressure
- Difference in means between entries who did exceed Maximum Permissible Heart Rate and those that did was significant for
 - Urine Specific Gravity
 - Pre-entry weight
 - Body Mass Index
 - Percent Weight loss (Pre entry – Post entry)



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Results



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- Real world experience matters
- Significant difference is observed in maximal permissible heart rate reached
- Significant difference in Urine Specific Gravity, Pre-entry weight, Body Mass Index, and % weight change are negated when adjusting for prior Demilitarization Protective Ensemble experience



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Discussion



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- Pueblo Chemical Agent-Destruction Pilot Plant training facility plays vital role in providing real world Demilitarization Protective Ensemble and Occupational Safety & Health Administration Level A experience for all selected chemical agent worker
- Training experience complemented with medical surveillance and real-time monitor provides worker protection from potential heat exhaustion and heat stroke
- Real-time heart rate monitoring provides real-time data on physiologic heat burden and early indicator for heat exhaustion and heat stroke
- New employee time from initial hire to number of Demilitarization Protective Ensemble entries to determine competency needs to be investigated