Firefighter Reproductive Health

Urban Fire Forum
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University of Arizona Zuckerman College of Public Health
Reproductive Health, Behavioral Health, and Women in the Fire Service – This presentation will review the results of reproductive health studies in male and female firefighters and explore the connection between reproductive and behavioral health among women in the fire service. We'll examine the correlation between self-reported clinical diagnosis of PTSD and its impact on ovarian reserve, its link to early menopause, and adverse reproductive outcomes. This groundbreaking research highlights the crucial link between mental health and reproductive function for female firefighters. The presentation includes discussions on research methodologies, statistical analysis, and implications for healthcare professionals and fire departments, emphasizing the need for early intervention and support to protect reproductive health in firefighters. DELIVERABLE (supporting the need for more research) 1:30-2:15

FFCCS participating fire departments at UFF (out of >100 total)

Anne Arundel
Boston
City of Los Angeles
City of Miami
Houston

Los Angeles County
Palm Beach County
Phoenix
San Antonio
Environmental Exposures & Reproductive Outcomes

Elevated ambient temperatures
- Preterm birth, low birthweight, stillbirths, ovarian reserve, sperm function and production, male fertility

Shift work
- Infertility and sub-fertility, sperm quality, reproductive hormone levels, low birthweight, preterm birth

Air pollution/wildfire smoke
- Preterm birth, low birthweight, male infertility, menstrual disruption

Menstrual disruption, infertility, miscarriages

1. Keuhn 2017
2. Chersich 2020
3. Gaskins 2021
4. Schliep 2019
5. Nkansah-Amanika 2010
6. Abdo 2019
7. Merklinger-Gruchala 2017
8. Sheridan 2019
9. Stocker 2014

Firefighter Reproductive Health

• Male firefighters at increased risk
  • sperm abnormalities\(^1\)
  • infertility (x 1.46-1.53)\(^2\)
  • birth defects in their children\(^3\)
    • total anomalous pulmonary venous return (x 3.1)
    • cleft palate (x 1.8)
    • cleft lip (x 2.2)
    • Transverse limb deficiency (x 2.2)
  • Exposure reduction may improve reproductive health

Fire Fighter Cancer Cohort Study (FFCCS)

**MISSION STATEMENT**
To conduct community-engaged research with the fire service to advance firefighter cancer control and prevention, as well as evaluation and prevention of other health conditions.

**TARGET GOAL**
10,000 firefighters enrolled and followed over 30 years.

**FIRE SERVICE PARTNERSHIP**
Fire service Oversight and Planning Board and firefighter research champions in each research project.

**BIOLOGICAL SAMPLES**
Collect blood, urine, and other biological samples at enrollment, every two years, and as needed after exposures.

**EXPOSURE DATA**
Collect exposure data from firefighters’ environment at the fireground, during training activities, and at other locations.

**INTEGRATION**
Integrate biological, environmental exposure, and health survey data through a centralized data center. Data protected by a Certificate of Confidentiality.
Community-Engaged Research

Research facilitated by firefighters for firefighters in partnership with academic researchers

Providing firefighter study participants with **TIMELY RESULTS REPORT BACK** to provide insight into the biological impact of their occupational exposures

Firefighter research champions and results report-back motivate the implementation of data driven **PREVENTIVE INTERVENTIONS** designed to reduce the incidence of cancer and other adverse health effects in the fire service that are **EFFECTIVE AND PRACTICAL**
Biomarkers

Biomarkers: a chemical, its metabolite, or the product of an interaction between a chemical and some target molecule or cell that is measured in the human body (Environmental Health Criteria 237. WHO, 2006).


Latency period 3 - 30+ years

Exposure → Cellular Changes → Cancer
Community-Engaged Research
- >4,000 total participants
  - >100 departments
  - 27 states
- >600 women firefighters
- >700 volunteer firefighters
- >700 wildland/WUI firefighters
- ~200 airport firefighters
- Many other groups
- Research centers
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<th>FFCCS Projects</th>
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<td>0) Pre-FFCCS</td>
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<tr>
<td>1) Framework</td>
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<td>2) Expansion</td>
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<td>3) PFAS</td>
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<td>4) WUI</td>
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<td>5) Women (2)</td>
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<td>6) Volunteers (2)</td>
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<td>7) Wildland (2)</td>
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<td>8) Arizona/PFAS</td>
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<td>9) High Risk</td>
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FFCCS Research Concepts

Prevention

Reduction

Exposures

Treatment

Biomarkers of effect

Early detection

Cancer and other outcomes

Support for presumptive laws
Improved imaging
Cell free DNA
Sperm

Recruits & incumbent firefighters
Changes over time

Subgroups
Women firefighters
Volunteer
Trainer
Investigator
WUI
Airport
Race/ethnicity
Wildland
Disaster

Other outcomes
Reproductive (women)
Reproductive (men)

Smoke (PAHs, etc.)
PFAS
BFRs and OPFRs
Diet and physical activity
Stress/PTSD
Shiftwork

Exposure Reduction
Improved respirator use
Dermal decontamination
Infrared sauna use

DNA methylation
MicroRNA
Metabolomics
SARS-CoV-2 antibodies
AMH (ovarian reserve)
DNA damage/adducts

Treatment
Broccoli seed extract
Blood/plasma donation

(Potential future research topics in blue font)
Prevention

- **Reduction**
  - Exposures

- **Treatment**
  - Biomarkers of effect
    - Broccoli Seed & Sprout Extract

- **Early detection**
  - Cancer and other outcomes
    - Blood/plasma donation
    - Broccoli seed extract

- **Exposure Reduction**
  - Improved respirator use
  - Dermal decontamination

- **Early detection**
  - Ovarian reserve and PTSD
FFCCS Women Firefighter Studies

**Current enrollment:** 515 women firefighters (including 279 incumbents & 236 recruits) across more than 40 fire departments

**Purpose:** To evaluate causes of stress, cancer, and adverse reproductive health effects in women firefighters, in order to plan effective interventions to mitigate these conditions.

**Aims:**

1. Compare stress and biomarkers of cancer risk and reproductive health in incumbent and recruit women firefighters
2. Evaluate changes in these conditions over time in recruit women firefighters
3. Develop, beta test, and assess feasibility of a peer support intervention for women firefighters
4. Compare changes over time in the reproductive reserve of women incumbent career and volunteer and recruit firefighters; and
5. Develop urine metabolomic approaches to evaluate exposures and toxic effects
Clinical marker of ovarian reserve (reproductive potential)

- AMH levels peak around age 25 and then begin to decline, mirroring the decline in number of oocytes in ovary (developing eggs)

https://carolinaconceptions.com/blog/an-update-on-amh
Factors Influencing AMH

AMH levels strongly associated with:

• Female fertility
• Age at menopause
• Potentially, risk of miscarriage and preterm birth

Biomarker for effects of environmental/occupational exposures that could affect the ovary

• Tobacco smoke
• Indoor fuel burning
• Pesticide use
• Stress

Firefighter AMH

Average dried blood spot AMH levels in firefighters 33% lower than non-firefighters

• Similar differences seen in AMH comparisons of smokers and non-smokers

https://www.mdpi.com/1660-4601/19/10/5981/pdf?version=1652523496
Personalized AMH Results Letter

Participants receive a results letter with:

- Details on AMH
- Instructions on how to read results
- Meaning of results
- Personalized figure with their results and comparison values*

*Median and 5-95th percentile range of AMH values for women in their age group from a sample of over 20,000 US women

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<thead>
<tr>
<th>Age</th>
<th>Median AMH Value</th>
<th>5th to 95th Percentile of AMH Values</th>
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<tbody>
<tr>
<td>18-25</td>
<td>3.730</td>
<td>1.06-13.51</td>
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<tr>
<td>26-30</td>
<td>3.530</td>
<td>0.64-10.49</td>
</tr>
<tr>
<td>31-35</td>
<td>2.490</td>
<td>0.45-9.21</td>
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<tr>
<td>36-40</td>
<td>1.580</td>
<td>0.14-6.83</td>
</tr>
<tr>
<td>41-45</td>
<td>0.480</td>
<td>0.002-3.04</td>
</tr>
<tr>
<td>46-50</td>
<td>0.070</td>
<td>0.003-1.12</td>
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<tr>
<td>&gt;50</td>
<td>0.002</td>
<td>0.002-0.25</td>
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Mental Health & Reproductive Health

- Anxiety, depression, and post-traumatic stress disorder are associated with infertility, miscarriage, and earlier time to menopause
- The mechanism as to which these exposures effect gynecologic health are unclear
- Few studies have looked at the effect of these exposures on serum AMH levels in humans
Methods

• Enrollment serum AMH
• Survey question: “Has a doctor or other healthcare provider EVER told you that you had:
  • Anxiety disorder
  • Depressive disorder
  • Post Traumatic Stress Disorder”
• Linear regression models to compare AMH levels in firefighters with mental health diagnoses to those without
# Mental Health and Reproductive Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Total (n=253)</th>
<th>Diagnosed Depression Yes (n=38)</th>
<th>Diagnosed Anxiety Yes (n=46)</th>
<th>Diagnosed PTSD Yes (n=22)</th>
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<tbody>
<tr>
<td><strong>Age, Mean (S.D.)</strong></td>
<td>32.5 (6.3)</td>
<td>31.9 (6.5)</td>
<td>31.5 (7.2)</td>
<td>35.0 (7.5)</td>
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<tr>
<td><strong>History of Infertility, n (%)</strong></td>
<td>18 (7.1%)</td>
<td>5 (13.2%)</td>
<td>7 (15.2%)</td>
<td>4 (18.2%)</td>
</tr>
<tr>
<td><strong>Previous Diagnosis of Endometriosis, n (%)</strong></td>
<td>7 (2.8%)</td>
<td>2 (5.3%)</td>
<td>2 (4.4%)</td>
<td>2 (9.1%)</td>
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Firefighter Mental Health and AMH

% Difference AMH

-22% Depression
-33% Anxiety
-66% PTSD
Potential mechanisms for low AMH with PTSD

• Chronic inflammation
  • PTSD is associated with increased serum interleukin-1 beta (IL-1β), IL-6, tumor necrosis factor alpha (TNF-α), interferon gamma (IFN-γ), and C-reactive protein (CRP)\(^1\)
  • Chronic inflammation is associated with low AMH\(^2\)
• Other?
• Exposure reduction may improve reproductive health


Implications and Interventions

• Healthcare professionals
  • Improve awareness of increased adverse reproductive outcomes in firefighters
    • Include information on effects of mental health conditions, particularly PTSD
    • Specific need for educational tools for OB/GYN providers
    • Identify and deliver mental health care tailored to firefighters
  • Fire departments
    • Educate their membership on reproductive health in firefighters and the need for continued focus on both mental health care and exposure reduction
    • Provide evidence-informed policies to support firefighters during PTSD, infertility, pregnancy, maternity leave, return to work, and breastfeeding
    • Encourage participation of their individual members when the opportunity for research on reproductive and mental health is available
Research Next Steps

• Seek additional research funding for reproductive health in firefighters
  • For male and female firefighters
  • Health of firefighters’ children

• Determine how mental health conditions lead to lower AMH in firefighters
  • Measure decline over time in AMH among firefighters with and without PTSD
  • Measure inflammatory markers in firefighters with and without PTSD

• Identify other exposures & risk factors leading to low AMH in firefighters
  • Use surveys and measure proteins in blood
  • Evaluate metabolic profiles in urine

• Evaluate the effectiveness of interventions to preserve reproductive reserve
  • Determine if improved treatment of PTSD can reduce inflammation
  • Test other intervention of interest to the fire service (e.g. intermittent fasting)
FFCCS Partners (partial list)

**Initial Academic/Government Partners**
University of Arizona; University of Miami; National Institute for Occupational Safety and Health (NIOSH); Fire Protection Research Foundation (FPRF); First Responder Center of Excellence (FRCE); Dongguk University (Korea); Illinois Fire Services Institute (IFSI); National Development & Research Institutes, Inc. (NDRI); etc.

**Initial Fire Service Partners**
Boston Fire Department /Local 718; Elephant Head Volunteer Fire Department; Firefighter Cancer Support Network (FCSN); Helmet Peak Volunteer Fire Department; IAFC/NFPA Metro Chiefs; International Association of Fire Fighters (IAFF); National Fallen Firefighters Foundation (NFFF); National Volunteer Fire Council (NVFC); Palm Beach County Fire Rescue; Plantation Volunteer Fire Department; Tucson Fire Department/Local 479; etc.

**Airport (PFAS) Partners**
Anchorage (AK); Fort Lauderdale (FL); Orange County (CA); Portland (OR); Seattle (WA); Tucson (AZ)

**Expansion Partners**
International Association of Arson Investigators (IAAI); Des Moines Arson Lund Local; Los Angeles County Fire Department/Local 1014; Orange County Fire Authority/Local 3631; North American Fire Training Directors (NAFTD); Texas A&M Engineering Extension Service (TEEX); International Association of Fire Chiefs (IAFC); etc.

**Volunteer Partners**
Rutgers, the State University of New Jersey; Toms River Fire Department (NJ); Piscataway Volunteer Fire Companies (NJ); Roseland Fire Department (NJ); Verga Fire Company (NJ); Totowa Fire Department (NJ); Dunellen Fire Department (NJ); Park Ridge Fire Department (NJ); Middletown Fire Department (NJ); Fairfax, County Fire & Rescue (VA); Chelsea Fire Department (ME); Hallowell Fire Department (ME); Monmouth Fire Department (ME)

**Women Firefighter Partners**
Anne Arundel County; Baltimore County/Local 1311; Boston/Local 718; City of Miami/Local 587; Fairfax County/Local 2068; Los Angeles County/Local 1014; Los Angeles (City)/Local 112/COA; Loudoun County/Local 3756; Miami-Dade/Local 1403; New York/Local 94/Local 854; Orange County/Local 3631; Phoenix/Local 493; San Francisco/Local 798; Tucson/Local 479, etc.

**Wildland Firefighter Partners**
CAL FIRE/Local 2881; Colorado Division of Fire Prevention and Control; Estes Valley Fire Protection District (CO); Hotchkiss Fire District (CO); Orange County/Local 3631 (CA)
Questions?