Respiratory Outcomes Related to Occupational Jet Fuel Exposure in the Military

Presentation for: PACT Act Symposium
Presented by: Terra D. Vincent-Hall, PhD, DABT, Senior Toxicologist, Exposure Science Program, Health Outcomes Military Exposures
Date: May 3, 2023

Disclaimer

The views expressed are solely the opinion of the authors and do not represent the official stance of the Department of Veterans Affairs, the Department of Defense, or the federal government.

Background

BLUF: There is a need for both VA and DoD to understand the future health implications of occupational jet fuel exposure.

- One of the most common exposures in military service
- Most published research details acute effects; lack of information on long-term outcomes
- VA often receives inquiries from Veterans and other stakeholders regarding related health effects.
- War Related Illness and Injury Study Center Intake Packet
  - About 90% of Veterans who completed an intake packet reported exposure to petrochemicals.
  - Over half reported exposure as frequently as every day while deployed.
- Airborne Hazards and Open Burn Pit Registry
  - Over 85% of participants report potential exposure to fuels.
  - The perception of these participants is that the exposure that had the most impact on their health was on-base air pollution (resulting from burning fuel or burn pits).

Section 202, § 1120: Presumption of service connection for certain diseases associated with exposure to burn pits and other toxins

(a) PRESUMPTION OF SERVICE CONNECTION.—For the purposes of section 1110 of this title, and subject to section 1113 of this title, a disease specified in subsection (b) becoming manifest in a covered veteran shall be considered to have been incurred in or aggravated during active military, naval, air, or space service, notwithstanding that there is no record of evidence of such disease during the period of such service.

Section 202, § 1120: Presumption of service connection for certain diseases associated with exposure to burn pits and other toxins

(b) DISEASES SPECIFIED.—The diseases specified in this subsection are the following: [list reduced to only respiratory conditions]

- Asthma that was diagnosed after service of the covered veteran as specified in subsection (c).
- Respiratory cancer of any type.
- Chronic bronchitis.
- Chronic obstructive pulmonary disease.
- Constrictive bronchiolitis or obliterative bronchiolitis.
- Emphysema.
- Granulomatous disease.
- Interstitial lung disease.
- Pleuritis.
- Pulmonary fibrosis.
- Sarcoidosis.
- Chronic sinusitis.
- Chronic rhinitis.
- Any other disease for which the Secretary determines, pursuant to regulations prescribed under subchapter VII that a presumption of service connection is warranted based on a positive association with a substance, chemical, or airborne hazard identified in the list under section 1119(b)(2) of this title.

Section 510: Report on health effects of jet fuels used by Armed Forces

(a) INITIAL REPORT.—**Not later than one year after the date of the enactment** of this Act, the Secretary of Veterans Affairs shall submit to the Committee on Veterans' Affairs of the Senate and the Committee on Veterans' Affairs of the House of Representatives, and make publicly available, a report on health effects of jet fuels used by the Armed Forces.

(b) CONTENTS.—The report submitted under subsection (a) shall include the following:

(1) A discussion of **the effect of various different types of jet fuels** used by the Armed Forces **on the health of individuals by length of exposure**.

(2) An identification of **the immediate symptoms** of jet fuel exposure **that may indicate future health risks**.

(3) A **chronology of health safeguards** implemented by the Armed Forces **intended to reduce the exposure** of members of the Armed Forces to jet fuel.

(4) An identification of any areas relating to jet fuel exposure about which new **research needs** to be conducted.

(c) FOLLOW-UP REPORT.—**Not later than five years after the date of the submittal** of the report under subsection (a), the Secretary shall submit to the committees referred to in such subsection **an update to such report**.

Systematic Literature Review – Respiratory Outcomes

- Seven primary occupational studies + several secondary sources (risk assessments, reviews, case reports)
- Slight evidence of an association (studies generally agree; however, limited number of studies and included significant biases/limitations)
- Acute outcomes:
  - Decreased lung function
  - Respiratory symptoms (e.g., dyspnea, cough with phlegm, runny nose)
- Long-term outcomes:
  - Chronic obstructive diseases
  - Respiratory symptoms (e.g., chronic cough)
- Additional studies are needed to:
  - Confirm specific respiratory outcomes related to jet fuel exposure
  - Identify immediate symptoms/acute outcomes indicative of long-term illnesses
  - Understand how duration of exposure impacts risk of respiratory outcomes

VA/DoD Tri-Service Occupational Jet Fuel Retrospective Investigation

PI: VHA HOME Exposure Science Program
Collaborators:
VHA HOME Epidemiology, VBA Military Exposure Team,
US Air Force School of Aerospace Medicine,
Defense Health Centers – Aberdeen and Portsmouth

A Collaborative, Retrospective Investigation

Key elements for a tri-service study:

- Define populations using Military Occupational Specialty (MOS) codes in all services
  - Exposed and unexposed codes
  - Service starting in 1995 or later through 2021
  - Active Duty only; service in only one branch
  - Minimum 2 years of service
- Evaluate medical data throughout and after military career for trends
  - **Healthcare encounters**
  - Mortality
  - Compensation claims
- May impact care, disability compensation, and preventive measure policies for individuals in certain occupations

Methods

- Veterans with encounters after separation (VHA encounters and Tricare claims); n = 540,204
- Exposure: Duration in years with jet fuel-exposed MOS code
- Cox Proportional Hazard Regression Models
  - AFHSD Surveillance and NIOSH Work-Related Respiratory Disease Manuals
  - Censor: Loss to follow-up, end of surveillance (1st Jan, 2020), death
  - Person-time: Time from separation to event or censor
  - Significance level: $p < 0.05$ (Correction for multiple comparisons applied)
  - Data displayed as quintiles of duration vs. unexposed

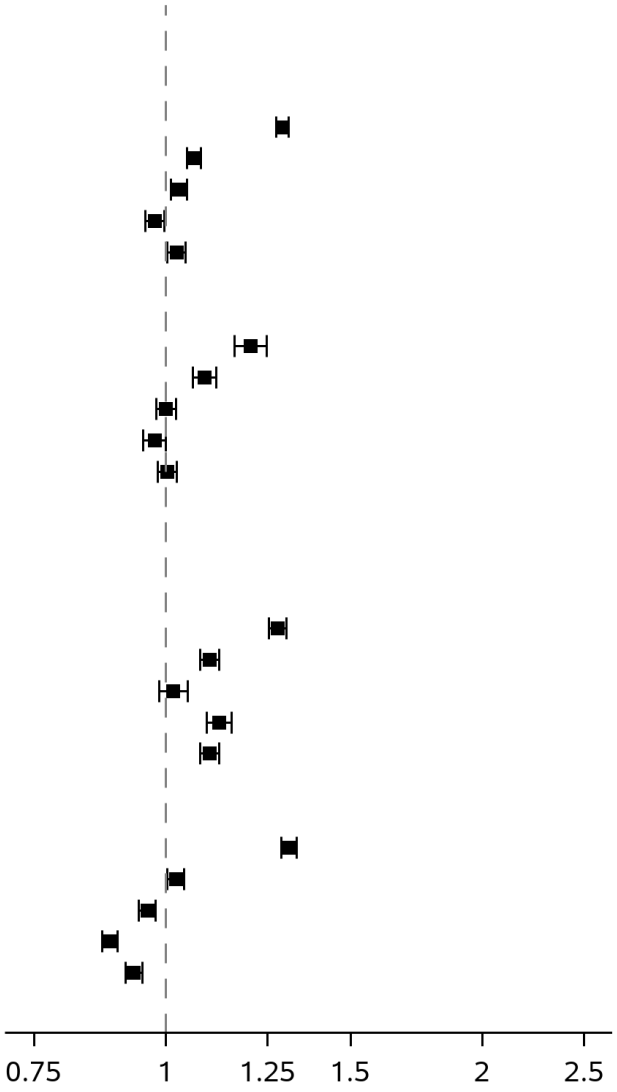
	N	Percent
Sex		
Female	102,955	19.1
Male	437,250	80.9
Race/Ethnicity		
Asian/Pacific Islander	16,137	3.0
Non-Hispanic Black	102,338	18.9
Hispanic	56,146	10.4
Alaskan Native/American Indian	3,864	0.7
Multiple Races/Other	9,675	1.8
Non-Hispanic White	352,045	65.2
Age		
≥ 28	156643	29
24 to 27	186439	34.51
≤ 23	197121	36.49
Service Branch		
Army	351,884	65.1
Air Force	188,321	34.9
Deployment		
Not Deployed	187,063	34.6
Deployed	353,142	65.4
Rank		
Enlisted	519,532	96.2
Officer	18,160	3.4
Warrant Officer	2,513	0.5
History of Tobacco Use		
Never Used	235,155	43.5
Current/Former User	305,050	56.5
Length of Service		
≥ 6	72691	13.46
3 to 5	262432	48.58
2 to 3	205082	37.96

Respiratory Healthcare Encounters

Diagnosis Frequency		
	Frequency	Percent
Condition Category		
Respiratory Conditions	**284,596**	**52.68**
Malignant Respiratory Neoplasms	196	0.04
Condition		
Allergic Rhinitis	125,501	23.23
Asthma	**31,597**	**5.85**
COPD	**28,942**	**5.36**
Chronic Sinusitis	**17,084**	**3.16**
Conditions Due to Chemical Fumes and Vapors	125	0.02
Hypersensitivity Pneumonitis	34	0.01
Influenza/Pneumonia	44,599	8.26
Other Interstitial Pulmonary Disease	347	0.06
Pneumoconioses	199	0.04
Respiratory Tuburculosis	538	0.10
Sleep Apnea	99,505	18.42
Upper Respiratory Infection	196,065	36.29
Malignant Neoplasm: Larynx	28	0.01
Malignant Neoplasm: Mesothelioma	7	0.00
Malignant Neoplasm: Other Respiratory	67	0.01
Malignant Neoplasm: Pleura	1	0.00
Malignant Neoplasm: Trachea, Bronchus and Lung	100	0.02

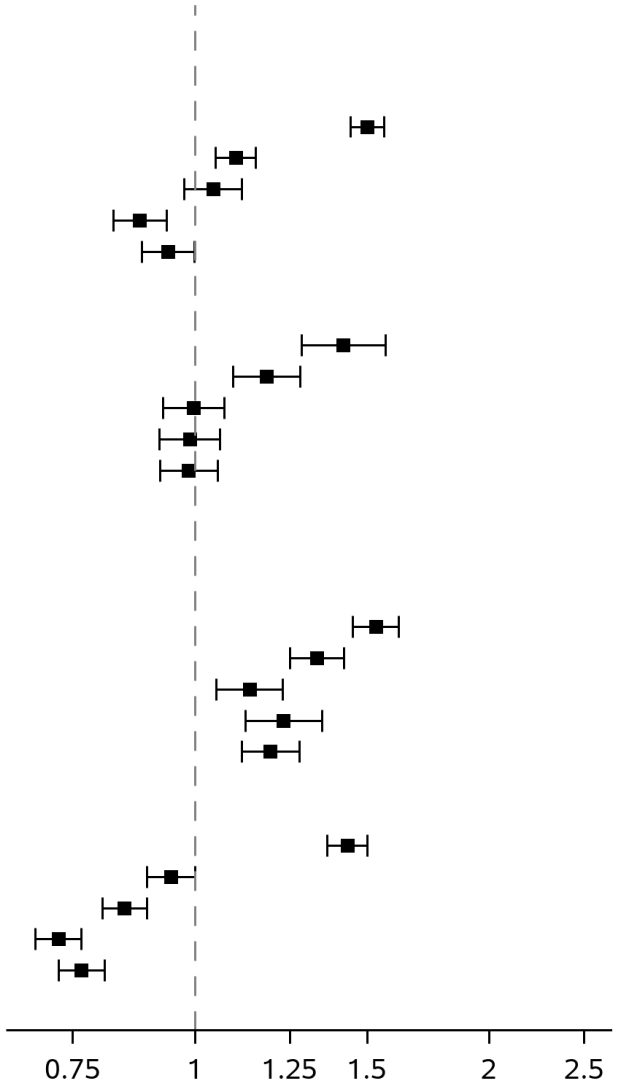
Results: All Respiratory Conditions (n = 284,596 events)

	HR (95% CI)	P Value
1. Deployment		
Deployed		
Q5: ≥ 7y,0m	**1.29 (1.27, 1.31)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**1.06 (1.05, 1.08)**	**< 0.001**
Q3: 3y,4m - 4y,6m	**1.03 (1.01, 1.05)**	**0.002**
Q2: 2y,6m - 3y,3m	**0.98 (0.96, 1.00)**	**0.022**
Q1: 1m - 2y,5m	**1.02 (1.00, 1.04)**	**0.018**
Unexposed	Reference	
Not Deployed		
Q5: ≥ 7y,0m	**1.21 (1.16, 1.25)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**1.09 (1.06, 1.12)**	**< 0.001**
Q3: 3y,4m - 4y,6m	1.00 (0.98, 1.02)	0.999
Q2: 2y,6m - 3y,3m	0.98 (0.95, 1.00)	0.060
Q1: 1m - 2y,5m	1.00 (0.98, 1.02)	0.999
Unexposed	Reference	
2. Service Branch		
Air Force		
Q5: ≥ 7y,0m	**1.28 (1.25, 1.30)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**1.10 (1.08, 1.12)**	**< 0.001**
Q3: 3y,4m - 4y,6m	1.02 (0.99, 1.05)	0.294
Q2: 2y,6m - 3y,3m	**1.12 (1.09, 1.16)**	**< 0.001**
Q1: 1m - 2y,5m	**1.10 (1.08, 1.13)**	**< 0.001**
Unexposed	Reference	
Army		
Q5: ≥ 7y,0m	**1.31 (1.29, 1.33)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**1.02 (1.00, 1.04)**	**0.017**
Q3: 3y,4m - 4y,6m	**0.96 (0.94, 0.98)**	**< 0.001**
Q2: 2y,6m - 3y,3m	**0.89 (0.87, 0.90)**	**< 0.001**
Q1: 1m - 2y,5m	**0.93 (0.92, 0.95)**	**< 0.001**
Unexposed	Reference	



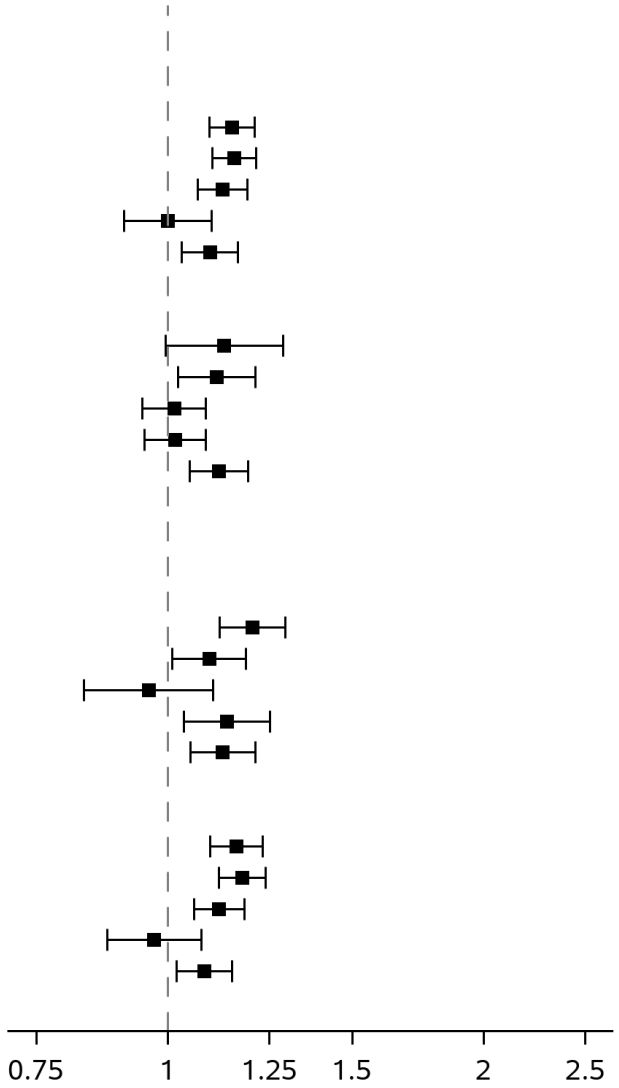
Results: Asthma (n = 31,597 events)

	HR (95% CI)	P Value
1. Deployment		
Deployed		
Q5: ≥ 7y,0m	**1.50 (1.44, 1.56)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**1.10 (1.05, 1.15)**	**< 0.001**
Q3: 3y,4m - 4y,6m	1.04 (0.98, 1.12)	0.221
Q2: 2y,6m - 3y,3m	**0.88 (0.82, 0.93)**	**< 0.001**
Q1: 1m - 2y,5m	**0.94 (0.88, 1.00)**	**0.047**
Unexposed	Reference	
Not Deployed		
Q5: ≥ 7y,0m	**1.42 (1.29, 1.57)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**1.18 (1.09, 1.28)**	**< 0.001**
Q3: 3y,4m - 4y,6m	1.00 (0.93, 1.07)	0.999
Q2: 2y,6m - 3y,3m	0.99 (0.92, 1.06)	0.999
Q1: 1m - 2y,5m	0.99 (0.92, 1.05)	0.999
Unexposed	Reference	
2. Service Branch		
Air Force		
Q5: ≥ 7y,0m	**1.53 (1.45, 1.62)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**1.33 (1.25, 1.42)**	**< 0.001**
Q3: 3y,4m - 4y,6m	**1.14 (1.05, 1.23)**	**0.001**
Q2: 2y,6m - 3y,3m	**1.23 (1.13, 1.35)**	**< 0.001**
Q1: 1m - 2y,5m	**1.19 (1.12, 1.28)**	**< 0.001**
Unexposed	Reference	
Army		
Q5: ≥ 7y,0m	**1.43 (1.37, 1.50)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**0.94 (0.89, 1.00)**	**0.048**
Q3: 3y,4m - 4y,6m	**0.85 (0.80, 0.89)**	**< 0.001**
Q2: 2y,6m - 3y,3m	**0.72 (0.69, 0.77)**	**< 0.001**
Q1: 1m - 2y,5m	**0.77 (0.73, 0.81)**	**< 0.001**
Unexposed	Reference	



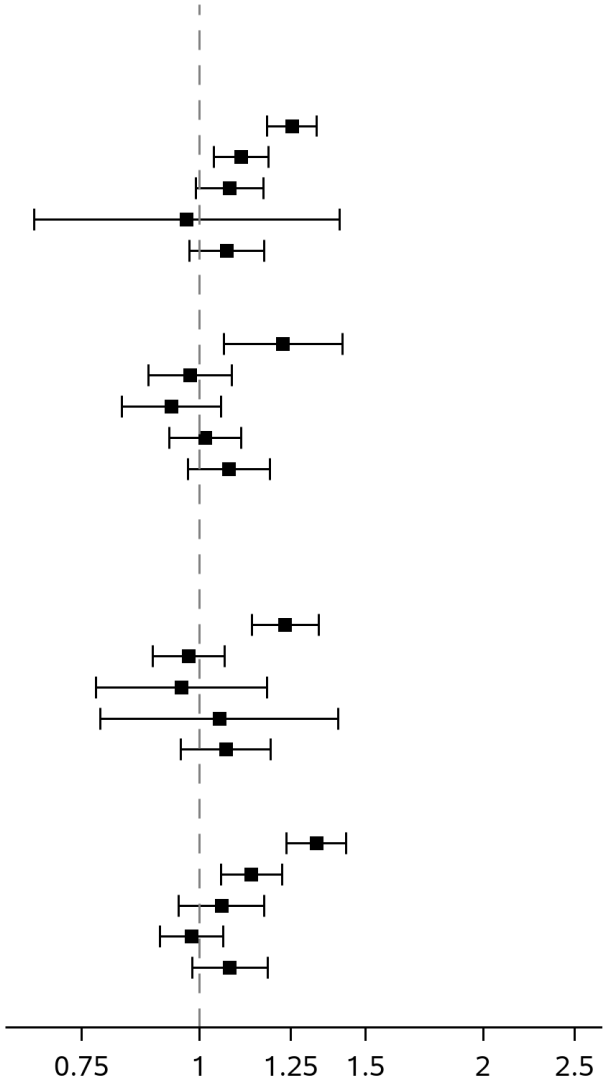
Results: COPD (n = 28,942 events)

	HR (95% CI)	P Value
1. Deployment		
Deployed		
Q5: ≥ 7y,0m	**1.15 (1.10, 1.21)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**1.16 (1.10, 1.22)**	**< 0.001**
Q3: 3y,4m - 4y,6m	**1.13 (1.07, 1.19)**	**< 0.001**
Q2: 2y,6m - 3y,3m	1.00 (0.91, 1.10)	0.999
Q1: 1m - 2y,5m	**1.10 (1.03, 1.17)**	**0.003**
Unexposed	Reference	
Not Deployed		
Q5: ≥ 7y,0m	1.13 (1.00, 1.29)	0.057
Q4: 4y,7m - 6y,11m	**1.11 (1.02, 1.21)**	**0.013**
Q3: 3y,4m - 4y,6m	1.01 (0.95, 1.09)	0.999
Q2: 2y,6m - 3y,3m	1.02 (0.95, 1.09)	0.999
Q1: 1m - 2y,5m	**1.12 (1.05, 1.19)**	**< 0.001**
Unexposed	Reference	
2. Service Branch		
Air Force		
Q5: ≥ 7y,0m	**1.20 (1.12, 1.29)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**1.10 (1.01, 1.19)**	**0.026**
Q3: 3y,4m - 4y,6m	0.96 (0.83, 1.11)	0.579
Q2: 2y,6m - 3y,3m	**1.14 (1.04, 1.25)**	**0.007**
Q1: 1m - 2y,5m	**1.13 (1.05, 1.21)**	**< 0.001**
Unexposed	Reference	
Army		
Q5: ≥ 7y,0m	**1.16 (1.10, 1.23)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**1.18 (1.12, 1.24)**	**< 0.001**
Q3: 3y,4m - 4y,6m	**1.12 (1.06, 1.18)**	**< 0.001**
Q2: 2y,6m - 3y,3m	0.97 (0.88, 1.08)	0.586
Q1: 1m - 2y,5m	**1.08 (1.02, 1.15)**	**0.009**
Unexposed	Reference	



Results: Chronic Sinusitis (n = 17,084 events)

	HR (95% CI)	P Value
1. Deployment		
Deployed		
Q5: ≥ 7y,0m	**1.25 (1.18, 1.33)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**1.11 (1.03, 1.18)**	**0.003**
Q3: 3y,4m - 4y,6m	1.08 (0.99, 1.17)	0.078
Q2: 2y,6m - 3y,3m	0.97 (0.67, 1.41)	0.880
Q1: 1m - 2y,5m	1.07 (0.97, 1.17)	0.157
Unexposed	Reference	
Not Deployed		
Q5: ≥ 7y,0m	**1.23 (1.06, 1.42)**	**0.006**
Q4: 4y,7m - 6y,11m	0.98 (0.88, 1.08)	0.999
Q3: 3y,4m - 4y,6m	0.93 (0.83, 1.05)	0.268
Q2: 2y,6m - 3y,3m	1.01 (0.93, 1.11)	0.999
Q1: 1m - 2y,5m	1.07 (0.97, 1.19)	0.159
Unexposed	Reference	
2. Service Branch		
Air Force		
Q5: ≥ 7y,0m	**1.23 (1.14, 1.34)**	**< 0.001**
Q4: 4y,7m - 6y,11m	0.97 (0.89, 1.06)	0.999
Q3: 3y,4m - 4y,6m	0.96 (0.78, 1.18)	0.692
Q2: 2y,6m - 3y,3m	1.05 (0.79, 1.40)	0.755
Q1: 1m - 2y,5m	1.07 (0.95, 1.19)	0.259
Unexposed	Reference	
Army		
Q5: ≥ 7y,0m	**1.33 (1.24, 1.43)**	**< 0.001**
Q4: 4y,7m - 6y,11m	**1.14 (1.05, 1.22)**	**< 0.001**
Q3: 3y,4m - 4y,6m	1.06 (0.95, 1.17)	0.319
Q2: 2y,6m - 3y,3m	0.98 (0.91, 1.06)	0.999
Q1: 1m - 2y,5m	1.08 (0.98, 1.18)	0.112
Unexposed	Reference	



Discussion

- Published literature on long-term respiratory outcomes related to occupational jet fuel exposure is sparse.
- The present study is the largest cohort study to examine this relationship in a military population.
- Our analyses suggest that occupational exposure to jet fuel is related to the occurrence of chronic respiratory conditions in Air Force and Army Veterans.
  - Conditions associated with occupational jet fuel exposure in this study are consistent with those presumed to be associated with service in Gulf War and the recent conflicts under the PACT Act.
  - Hazard ratios for certain respiratory outcomes increase with duration in fuel-exposed military occupational specialties.
  - Patterns of some respiratory diseases may differ by branch.
- Limitations
  - MOS used as a proxy for exposure
  - Limited to encounters captured by VHA/Tricare

Future Work

- Retrospective study
  - Continuation of encounters, mortality, and claims analyses
  - Incorporate DOEHRS-IH data to characterize exposure intensity by MOS
  - Request Navy/Marine Corps roster and other data
- Complementary biomarker study – collaboration with RM MIRECC, NHRC, and 711th HPW
- Section 510
  - Draft report submitted for internal clearance on 4/28/23, due to Congress by 8/10/2023
  - Expand literature review (animal and mechanistic studies; other populations)
  - Incorporate study findings into the total evidence
  - Follow-up report due by 8/10/2028