Lung Function of Male Metropolitan Fire Fighters compared to General Population Controls

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COPD Images by Peter Jeffery - Part 1

SEM showing flakes of mucus overlying fields of cilia

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SEM showing the blanket of mucus over cilia that develops as a result of exposure to cigarette smoke

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Forced Vital Capacity (FVC)

**DEFINITION:**
Maximal volume of air exhaled with maximal forced effort from a position of maximal inspiration expressed in litres (BTPS).

**PERFORMANCE of FVC:**
- Check spirometer calibration
- Prepare subject
- Instruct and demonstrate test to subject
- Perform manoeuvre
- Repeat for a minimum of 3 manoeuvres, no more than 8 are usually required
- Check test reproducibility
Timed Forced Expiratory Volume (FEV\textsubscript{t})

**DEFINITION:**
The volume of air exhaled in the specified time during the performance of the FVC, e.g., FEV\textsubscript{1} is the volume of air exhaled during the first second of the FVC, expressed in litres (BTPS).

**PERFORMANCE STANDARD:**
Quote the best

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COPD: Natural History

![Image of COPD natural history graph]

Fletcher C & Peto R. BMJ 1977;1:1645-8
World Trade Centre Data

RESPIRATORY SYMPTOMS FOR DIFFERENT EXPOSURE GROUPS
YEAR 1

- Daily Cough
- Short of Breath
- Wheeze
- Chest Pain
- Any Lower Respiratory System

Arrival Time Exposure Category
- Group I = AM of 9/11/01
- Group II = Next 36 hours (Day 1 PM & Day 2)
- Group III = After Day 2
WTC

LOWER RESPIRATORY SYMPTOMS

FDNA WTC Rescue Workers [%]

Pre-WTC
WTC 9/11
Post-WTC mo. 1
Post-WTC yr. 1
Post-WTC yrs. 2-4

Daily Cough
Short of Breath
Wheeze
Chest Pain

Loss of FEV1

PULMONARY FUNCTION LOSS:
FIRST YEAR AFTER 09/11/2001
BY ARRIVAL TIME EXPOSURE CATEGORY

Adjusted FEV1 Loss (mL)

-500
-450
-400
-350
-300
-250
-200
-150
-100
-50
0
-31
-31
-31
-368
-373
-357

Arrival Time Exposure Category
Group I = AM of 9/11/01;
Group II = Next 36 hours (Day 1 PM & Day 2); Group III = After Day 2

Primary Care
Respiratory
Research Unit
Background

- Despite personal protection measures fire-fighters are at increased risk of adverse health effects (Guidotti, 1995)

- Fire-fighters: increased BHR and reduced lung function after occupational exposure (Greven, 2011; Large, 1990; Luke, 1980; Liu, 1992)

- Studies looking at changes in lung function over time are scarce and have shown conflicting results:
  - accelerated lung function decline (Tepper, 1991)
  - no accelerated lung function decline (Burgess, 1990; Musk, 1977; Musk, 1982)

- Only 2 previous studies compared course of lung function between fire-fighters and population controls (Spaans, 1982; Horsfield, 1988)

- Both >15 yrs old; working conditions changed considerably
Study aims

1. Assess health status of professional South Australian metropolitan fire-fighters in terms of lung function and health-related quality of life

2. Compare these health outcomes with males from the general South-Australian population

3. Explore associations between fire-fighters’ exposure to dust, smoke and fire and these health status measures
### Characteristics of MFS and NWAHS study samples

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Male fire-fighters (n=501)</th>
<th>Male NWAHS controls (n=1324)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>43.8 (8.3)</td>
<td>43.2 (10.9)</td>
<td>0.182</td>
</tr>
<tr>
<td>Body Mass Index (kg/m²)</td>
<td>27.6 (3.1)</td>
<td>28.0 (4.9)</td>
<td>0.024</td>
</tr>
<tr>
<td>Smoking status, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>current smokers</td>
<td>50 (10.2)</td>
<td>387 (29.5)</td>
<td></td>
</tr>
<tr>
<td>former smokers</td>
<td>123 (25.2)</td>
<td>392 (29.9)</td>
<td></td>
</tr>
<tr>
<td>never smokers</td>
<td>315 (64.5)</td>
<td>534 (40.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>FEV₁ (litres)</td>
<td>4.39 (0.68)</td>
<td>3.66 (0.73)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>as % predicted</td>
<td>103.4 (12.1)</td>
<td>89.5 (13.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>FVC (litres)</td>
<td>5.86 (0.83)</td>
<td>4.50 (0.84)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>as % predicted</td>
<td>110.0 (11.6)</td>
<td>88.5 (12.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>FEV₁/FVC (%)</td>
<td>75.0 (6.4)</td>
<td>81.4 (6.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>as % predicted</td>
<td>83.7 (7.7)</td>
<td>100.8 (8.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>FEF₂₅₋₇₅ (litres/second)</td>
<td>3.53 (1.17)</td>
<td>3.73 (1.14)</td>
<td>0.002</td>
</tr>
<tr>
<td>as % predicted</td>
<td>86.0 (25.9)</td>
<td>92.1 (28.1)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Results Phase 1 MFS study:
FEV₁ by age for all male fire-fighters and controls

Schermer T et al., 2010

Results Phase 1 MFS study:
FVC by age for all male fire-fighters and controls

Schermer T et al., 2010
Previous results MFS study:
FEV<sub>1</sub>/FVC by age for all male fire-fighters and controls

- FEV<sub>1</sub>/FVC <0.70:
  - fire-fighters: 19%
  - controls: 6%
  - p<0.001
- FEV<sub>1</sub>/FVC < LLN:
  - fire-fighters: 28%
  - controls: 10%
  - p<0.001

Schermer T et al., 2010

Mean SF-36 scale scores for all male fire-fighters and controls

- p<0.001
- p=0.007
- p=0.009
- p<0.001
- p=0.001
- p=0.724
- p=0.009
- p=0.001

Primary Care Respiratory Research Unit
Conclusions

- Male metropolitan fire-fighters are in better (respiratory) health than the general population is

- SF-36 mental health scale significantly lower in fire-fighters, but not 'clinically' meaningful

- Observed dose-effect relation between self-reported occupational exposure and fire-fighters’ lung function and symptoms warrants further investigation

Aims for MFS study, stage 2

1. Investigate how changes in lung function over time in male metropolitan fire-fighters compare with those in male general population controls

2. Compare risk of accelerated lung function decline between fire-fighters and population controls

3. Examine association between fire-fighters’ use of personal respiratory protection devices and risk of accelerated lung function decline
Design & study populations

- Prospective (~3-year) data from assessment of male SA Metropolitan Fire Service (MFS) fire-fighters
- Prospective (~3.5-year) data from random sample of SA males in same age range from North-West Adelaide Health Study (NWAHS) biomedical cohort (Grant, 2006)
- 281 fire-fighters, 933 NWAHS controls

Measurements

- In fire-fighters and NWAHS controls:
  - spirometry
  - study questionnaire: smoking, symptoms, doctor-diagnosed respiratory conditions, ...
- Only in fire-fighter cohort:
  - occupational exposures, use of respiratory protection devices
  - Involvement in common fire-fighting tasks in last 12 months: knockdown, overhaul, fire investigation, HazMat investigation
  - Wear of respiratory protection:
    never or rarely (less than 40% of the time)
    some of the time (40 to 60%)
    often or frequently (60 to 100%)
SAMFS’ use of respiratory protection

- SAMFS has been using various types of compressed air/decant systems since the early 1970s
- Since 1997 until: AirMaxx self-contained breathing apparatus systems (MSA Auer, Berlin, Germany)

Selection and drop-out

- SA Metropolitan Fire Service Study
  - Written declaration of intent/consent n=135
  - Willing to participate n=376
  - Stage 1 biological (questionnaire assessment): n=352
  - Selection of eligible males: n=123
  - Stage 2 biological (questionnaire assessment): n=123
  - Lost to follow-up: n=258

- North West Adelaide Health Study
  - Eligible population sample: n=1,230
  - Willing to participate: n=1,078
  - Stage 1 biological (questionnaire assessment): n=467
  - Selection of all males: n=2,988
  - Stage 2 biological (questionnaire assessment): n=293
  - Exclusion of females: n=2,672
  - Exclusion of males aged <18 or >65 years: n=464
  - Lost to follow-up: n=1,991
Characteristics of study samples

<table>
<thead>
<tr>
<th></th>
<th>Male fire-fighters (n=281)</th>
<th>Male NWAHS controls (n=933)</th>
</tr>
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<tbody>
<tr>
<td>Age (years)</td>
<td>43.3 (8.0)</td>
<td>42.7 (9.8)</td>
</tr>
<tr>
<td>Smoking status, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>current smokers</td>
<td>26 (9)</td>
<td>257 (27)</td>
</tr>
<tr>
<td>former smokers</td>
<td>64 (23)</td>
<td>287 (31)</td>
</tr>
<tr>
<td>never smokers</td>
<td>190 (88)</td>
<td>394 (42)</td>
</tr>
<tr>
<td>FEV₁ (litres)</td>
<td>4.51 (0.66)</td>
<td>3.72 (0.70)</td>
</tr>
<tr>
<td>as % predicted</td>
<td>104.9 (11.8)</td>
<td>90.1 (13.6)</td>
</tr>
<tr>
<td>FVC (litres)</td>
<td>6.02 (0.82)</td>
<td>4.57 (0.81)</td>
</tr>
<tr>
<td>as % predicted</td>
<td>111.3 (11.4)</td>
<td>89.2 (12.3)</td>
</tr>
</tbody>
</table>

Annual change (SE) in FEV₁ by age stratum for non-smoking fire-fighters (n=255) and population controls (n=678)

p=0.005*
Annual change (SE) in FVC by age stratum for non-smoking fire-fighters (n=255) and population controls (n=678)

Accelerated FEV₁ decline in fire-fighters and controls

- 72 (27%) fire-fighters and 363 (39%) controls showed accelerated FEV₁ decline (i.e., >0.050 L/year)

- Lower odds of accelerated FEV₁ decline in fire-fighters compared to controls:
  OR=0.60 (95%CI 0.44 to 0.83; p=0.002)

(from logistic regression analysis controlling for age, smoking status and history of chronic respiratory conditions)
Changes in lung function and use of respiratory protection in fire-fighters

• 78% of fire-fighters on the job for >6 years

• 80% of fire-fighters reported involvement in fire knockdown in the past 12 months

• Fire-fighters not involved in knockdown were:
  • 5 yrs older (47.2 [7.0] vs. 42.5 [8.0] years; p<0.001)
  • more often current/former smokers (46% vs. 29%; p=0.027)
  • more likely to have history of chronic respiratory disease (24% vs. 13%; p=0.039)

Changes in lung function and use of respiratory protection in fire-fighters

• Fire-fighters with inadequate use of respiratory protection during knockdown (n=50) were also more likely not to wear protection during other tasks:
  – overhaul: 87% (p<0.001)
  – fire investigation: 73% (p=0.063)

• Inadequate use of respiratory protection more common in older than in younger fire-fighters:
  – 12% in ≤40 yrs
  – 27% in 41-50 yrs
  – 40% in >51 yrs (p=0.039)
Annual change (SE) in FEV₁ by age group and use of respiratory protection during knockdown in fire-fighters (n=281)

Use of respiratory protection during fire knockdown and accelerated FEV₁ decline

- Compared to often or frequent use:
  - Never or rarely: OR=2.2 (p=0.044)
  - Some of the time: OR=1.7 (p=0.248)

- Odds of accelerated FEV₁ decline in current smokers: 4.6 (95%CI 1.7, 12.3)

(from logistic regression analysis controlling for smoking status, age and history of chronic respiratory disease)
Conclusions

• Younger generations of fire-fighters showed increase in lung function over time relative to older generations; population controls showed decline across all age groups

• Fire-fighters had lower risk of accelerated FEV₁ decline than population controls

• Fire-fighters: smokers and those with inadequate use of respiratory protection had increased risk of accelerated FEV₁

• Need for improvement in consistent use of respiratory protection