Firefighter Cardiorespiratory Fitness Pilot: Initial Phase Results

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Introduction

Study Background

≥ 73-80% firefighters considered <u>overweight or obese</u>

- Possible misclassification
- BMI: **<u>non-specific</u>** body composition metric
- Body fat percentage (BF%) can better classify muscular populations
- DXA is a safe, cost-effective, and simple technology to measure BF%
- Most clinicians believe (incorrectly) BMI is a <u>good individual measure</u>

Firefighter cardiorespiratory fitness (CRF) standards

- **<u>NFPA 1582 guidelines</u>**: VO_{2max} ≥ 42 mL/kg/min
- Most fire departments **<u>do not</u>** use such standards!
- **<u>No studies</u>** correlating DXA measures and measured VO_{2max}

Study Aims

1. Correlation of body composition measures
2. Correlation of VO_{2max} with body composition measures
3. Evaluation of obesity by body composition methods
4. Development of an improved VO_{2max} model
5. Evaluation of cost-effectiveness of VO_{2max} (Phase 2)
6. Correlation of VO_{2max} with CV risk measures (Phase 2)

Methods

1. Survey and Rowing Test

- Survey of personal and employment demographics
- Measurements: height, weight, resting heart rate
- On-site 2000m Concept 2 (C2) rowing machine test
- VO_{2max} estimates: C2 highly/not highly-trained, TDPS

2.Treadmill VO_{2max} Testing

- Mask-based Bruce protocol

3. DXA Body Composition

- Whole-body DXA scan
- Hologic body comp.: NHANES vs. "classic" methods

Results

Demographics

- 52 subjects enrolled, 48 male, 4 female
- Mean age: 42.8 (SD: 8.1)

Body Comp. (M)

Body Comp. Measure	Mean	SD	Classification
Weight (lbs)	208.1	30.5	
Height (in)	71.3	2.6	
Waist Circ. (in)	**38.9**	4.1	**Low**
BMI (kg/m^2)	**28.9**	3.9	**Overweight**
FM (%)	27.5	5.5	**Fair-Poor-Very Poor**
FM, classic (%)	23.6	5.7	**Fair-Poor-Very Poor**
LM (%)	69.0	5.1	
LM, classic (%)	72.9	5.4	

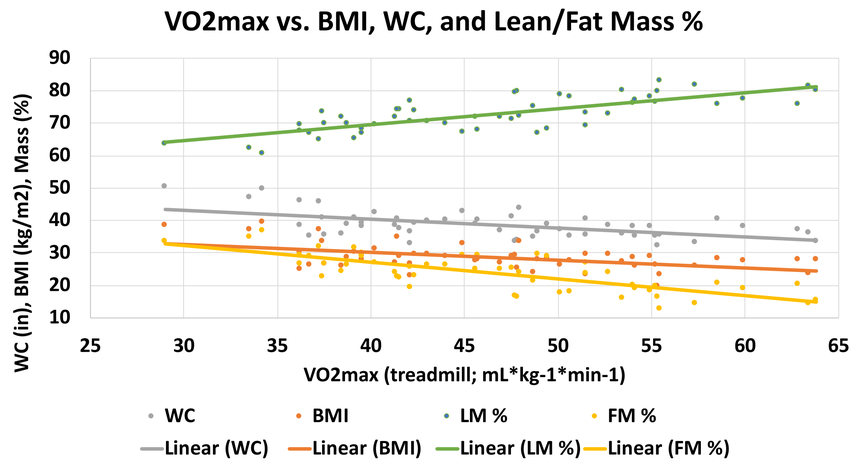
Body Comp. (F)

Body Comp. Measure	Mean	SD	Classification
Weight (lbs)	165.4	18.9	
Height (in)	66.9	3.0	
Waist Circ. (in)	**35.1**	1.5	**Low**
BMI (kg/m^2)	**26.0**	2.1	**Overweight**
FM (%)	29.9	4.4	**Excellent-Good-Fair**
FM, classic (%)	26.1	4.7	**Excellent-Good-Fair**
LM (%)	66.5	4.4	
LM, classic (%)	70.3	4.6	

	Cardiorespiratory Fitness Classifications (VO_{2max}), mL/kg/min					
Age (yr)	**Very Poor**	**Poor**	**Fair**	**Good**	**Excellent**	**Superior**
Males						
Percentile	< 5 - 19	20-39	40-59	60-79	80-94	> 95
20-29	**< 29.0 - 38.0**	**38.1-44.8**	**44.9-50.1**	50.2-57.0	57.1-66.2	> 66.3
30-39	< 27.2 - 34.0	**34.1-39.5**	39.6-45.1	**45.2-51.5**	51.6-59.7	> 59.8
40-49	< 24.2 - 30.4	30.5-35.6	**35.7-40.2**	40.3-46.6	**46.7-55.5**	> 55.6
50-59	< 20.9 - 26.0	26.1-30.6	30.7-35.0	**35.1-41.1**	**41.2-50.6**	> 50.7
60-69	< 17.4 - 22.3	22.4-26.5	26.6-30.4	30.5-36.0	**36.1-42.9**	> 43.0
Females						
Percentile	< 5 - 19	20-39	40-59	60-79	80-94	> 95
20-29	< 21.7 - 28.5	**28.6-34.5**	**34.6-40.5**	**40.6-46.4**	46.5-55.9	> 56.0
30-39	< 19.0 - 24.0	24.1-28.1	28.2-32.1	**32.2-37.4**	**37.5-45.7**	> 45.8
40-49	< 17.0 - 21.2	21.3-24.8	24.9-28.6	28.7-33.9	**34.0-41.6**	> 41.7
50-59	< 16.0 - 19.0	19.1-21.7	21.8-25.1	25.2-28.5	**28.6-35.8**	> 35.9
60-69	< 13.4 - 16.4	16.5-18.8	18.9-21.1	21.2-24.5	24.6-29.3	> 29.4

Participant **measured VO_{2max}** averages denoted in reference table in **BOLD**.
Participant **estimated C2 VO_{2max}** averages denoted in reference table in **RED BOLD**.
Note: estimated VO_{2max} means result in reduced classification

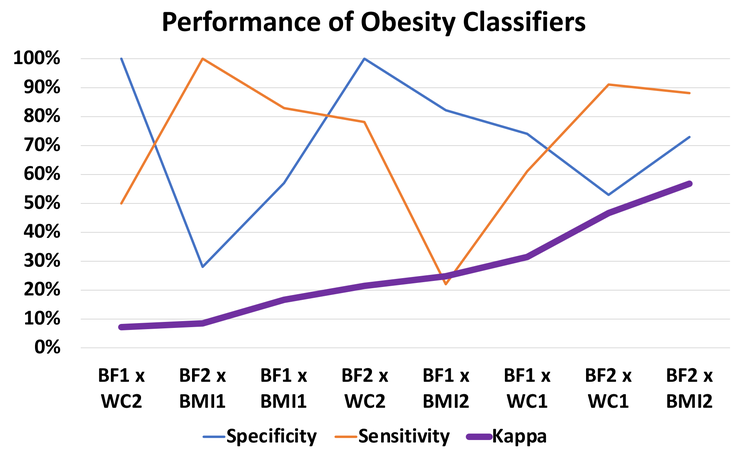
Correlation of VO_2 & Body Composition



Body Comp. Measure	β Coeff.	R^2
FM (%)	-0.34	**0.58**
FM (%), classic	-0.32	**0.58**
LM (%), classic	+0.34	**0.58**
LM (%)	+0.36	**0.58**
Total FM, classic	-0.20	**0.51**
Total FM	-0.20	**0.49**
WC	-0.13	**0.32**
BMI	-0.32	**0.27**
Total LM, classic	-0.01	0.002
Total LM	-0.02	0.003

- Total and percent FM fit VO_{2max} fairly well
- LM % fits well, but total LM does not
- BMI not as well-correlated as DXA measures
- **<u>FM% best-correlated with VO_{2max}</u> vs. other body comp. measures**

Classification of Obesity



Obesity Criteria	Body Comp. Classification Criteria
BMI1	Overweight OR obese
BMI2	Obese
WC1	High or very high
WC2	Very high
BF1	Poor or very poor
BF2	Very poor

Only moderate agreement with "obese" BMI and "very poor" BF

Obesity measures <u>do not agree</u>!

Modeling VO_{2max}

Body composition measures

Measure	β Coeff.	R^2
WC	-0.13	0.32
BMI	-0.32	0.27
Weight	-0.07	0.18

Other measures

Measure	β Coeff.	R^2
Age	-0.09	**0.09**
HUNT 2	0.97	**0.07**
BMC	2.28	**0.21**

HUNT 2: Physical activity questionnaire correlated with VO_{2max}.
Kurtze N, Rangul V, Hustvedt BE, Flanders WD. Reliability and validity of self-reported physical activity in the Nord-Trøndelag Health Study (HUNT 2). *Eur J Epidemiol*. 2007;22(6):379-87.

VO_{2max} estimates

Estimate	β Coeff.	R^2
C2, not highly-trained	0.25	**0.63**
C2, highly-trained	0.16	**0.54**
TDPS	0.25	**0.63**

TDPS: Texas Dept. of Public Safety VO_{2max} estimates using C2 rower.

Preliminary VO_{2max} model with R^2 = 0.7

Including C2 $VO2_{max}$ estimate, FM%, bone mineral content (BMC), age, gender

Initial Conclusions

- **FM% best body composition measure to estimate VO_{2max}**
- **Classification of obesity is not consistent**
- **Body composition measures can improve a VO_{2max} model**
- **Evaluation of firefighters may benefit from use of FM%**