

HQ U.S. Air Force Academy

Integrity - Service - Excellence

Comparison of the 1.5 Mile Run Times at 7,200 Feet and Simulated 850 Feet in a Hyperoxic Room



**Lt Col Michael Zupan, Ph.D.
Director, USAFA Human Performance Lab**

Report Documentation Page

*Form Approved
OMB No. 0704-0188*

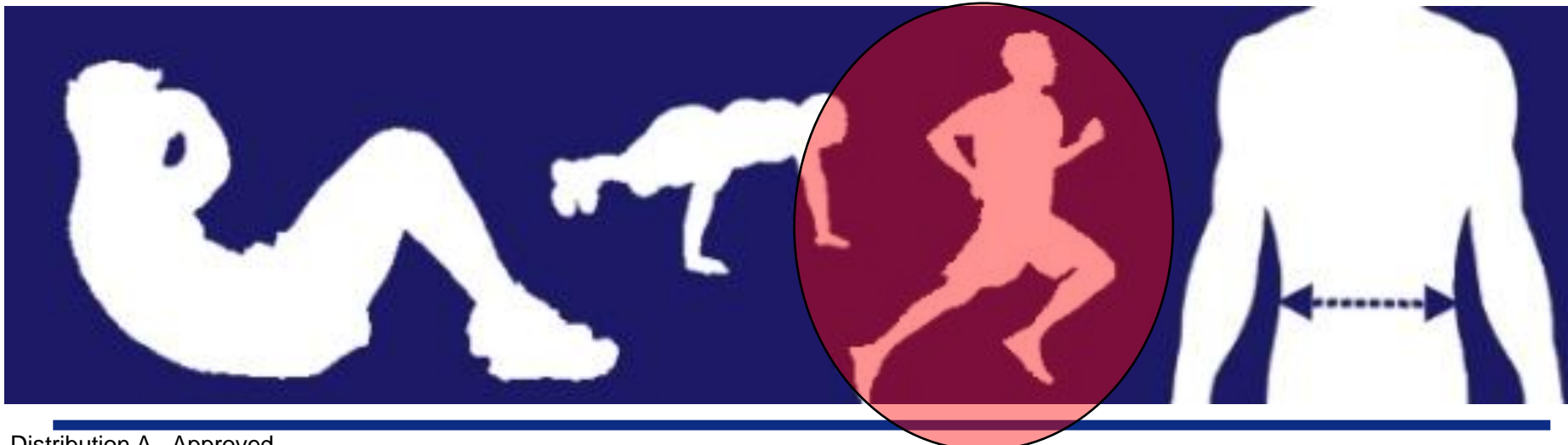
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE 02 AUG 2011	2. REPORT TYPE N/A	3. DATES COVERED			
4. TITLE AND SUBTITLE Comparison of the 1.5 Mile Run Times at 7,200 Feet and Simulated 850 Feet in a Hyperoxic Room		5a. CONTRACT NUMBER			
		5b. GRANT NUMBER			
		5c. PROGRAM ELEMENT NUMBER			
6. AUTHOR(S) Zupan Michael F.		5d. PROJECT NUMBER			
		5e. TASK NUMBER			
		5f. WORK UNIT NUMBER			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) United States Air Force Academy Human Performance Laboratory 2169 Fieldhouse Dr USAFA CO 80840		8. PERFORMING ORGANIZATION REPORT NUMBER			
		10. SPONSOR/MONITOR'S ACRONYM(S)			
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		11. SPONSOR/MONITOR'S REPORT NUMBER(S)			
		12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited.			
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 25	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



Study Objective

This study investigated if there are differences in **aerobic** performance between altitude and simulated sea level environments and if differences are evident between conditions, to what extent?





Background Information

- **1968** - Dr. Ken Cooper develops the 12 minute run fitness test as an easy, inexpensive and relatively accurate way to estimate VO_2 max, or aerobic fitness, in large groups of Air Force personnel. (R = .897)
 - Based on results of 115 airmen
 - Better indicator of cardiovascular fitness than the 600 yard run.
- Later Dr. Cooper developed the 1.5 mile test
- **1992** - Cycle ergometry test was implemented to “predict” VO_2 max.





Background Information (cont)

- **2004** - New Air Force fitness program was implemented that once again used the 1.5 mile test.
- **2005** - An altitude adjustment was implemented for airmen stationed above 5,000 ft. (1.75 pts)
- **2010** - New Air Force fitness test program was implemented, which still used the 1.5 mile run to test aerobic fitness, but the altitude adjustment for the Air Force Bases located at moderate altitude is removed.





Background Information (cont)

“The high altitude calculation was removed as all individuals are already given a temporary exemption of six weeks to adapt to the altitude differences between locations”

and

“With six weeks to acclimatize and continue training at altitude, members' 1.5 mile run performance should not be appreciably degraded”

and

“Exercise research indicates that a score adjustment for people taking the revised Air Force Physical Fitness Test at higher altitudes is not needed. The VO_2 max or aerobic fitness, the factor we are measuring with the 1.5 mile run, is not measurably altered in a non-acclimated member testing from sea level up to 7,000 feet.”

(Air Force Fitness Program Web Site FAQ)

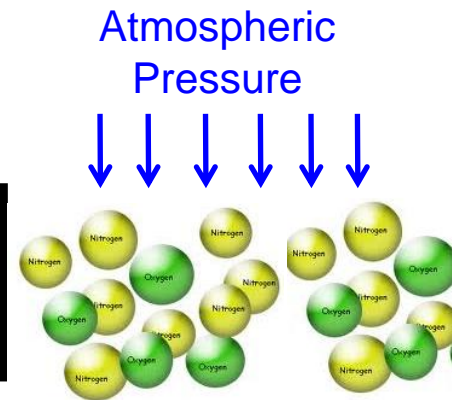




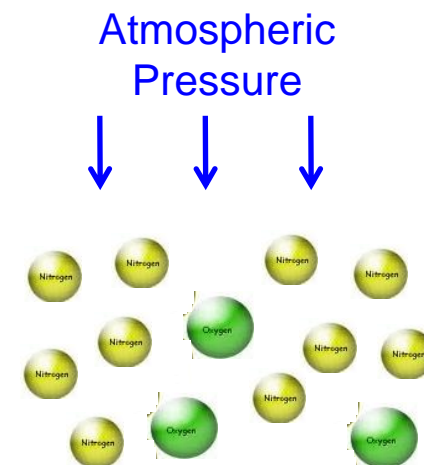
Background Information (cont)

- As altitude is increased, barometric pressure decreases
 - Results in less oxygen per given volume of air than at sea level
 - Known as **hypobaric hypoxia**
- Current research shows that total acclimatization can take up to 4-6+ months (Brothers, 2008; Brothers, 2007)
- Aerobic endurance still is impaired even with total acclimatization (Brothers, 2008; Brothers, 2007)
- Training intensities are reduced at altitude which results in deconditioning of the body (TB 505, 2010)
- To date, it is unknown the exact amount of decrement associated with various levels of the hypobaric hypoxic environments.

Oxygen content at Sea Level (20.9%)



Oxygen content at Altitude (20.9%)



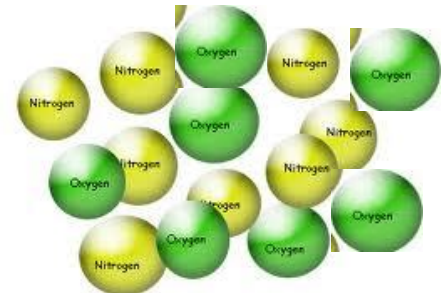


Protocol

- Time requirement for each subject was ~2 hours
 - **30 min- ICD and VO_{2max} introduction**
 - **30 min- VO_{2max} and DXA scan**
 - **30 min- 1.5 mile run in first condition**
 - **30 min- 1.5 mile run in opposite condition**
- All 1.5 mile runs were performed in the Colorado Altitude Tent (CAT) in normal moderate altitude environment (~7,200 ft) or **normobaric hyperoxic environment** (oxygen content increased while barometric pressure stayed the same) to simulate ~850 ft.
- Order of running conditions were randomized.
- Only 24 to 72 hours between 1.5 mile runs
- Distance was the only factor known by the subjects during the 1.5 mile runs



**Oxygen Content in
CAT (~26.5%)**





Creating a Hyperoxic Environment

Partial Pressure of O₂

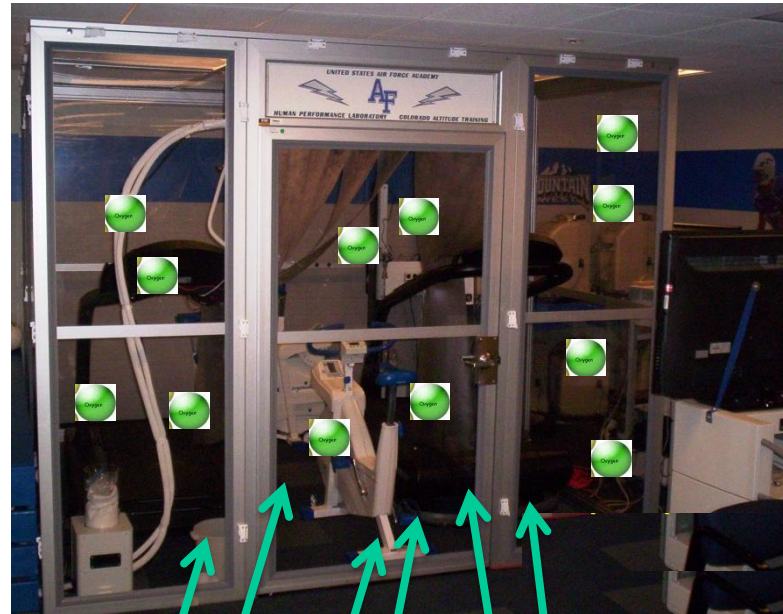
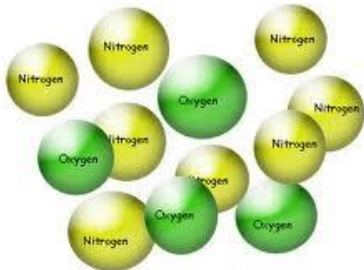
SL

$$.21 * 760 \text{ mmHg} = \text{PO}_2 \text{ of } 160 \text{ mmHg}$$

7,200 FT

$$.21 * 570 \text{ mmHg} = \text{PO}_2 \text{ of } 120 \text{ mmHg}$$

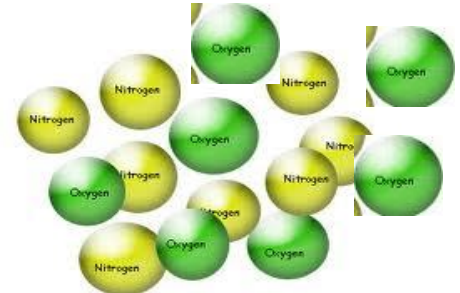
Oxygen content at
Altitude (20.9%)



CAT

$$.265 * 570 \text{ mmHg} = \text{PO}_2 \text{ of } 152 \text{ mmHg}$$

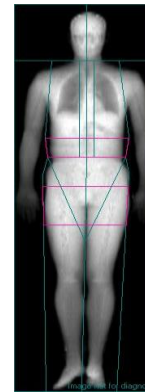
Oxygen content in
CAT (~26.5%)





Dual Energy X-Ray Absorptiometry (DXA) Scanner for Body Composition

- “Gold Standard” for body composition
- Assessments provide :
 - % fat mass
 - % lean body mass
 - Bone density



REGION	TOTAL	Left	Right
Arms	14.2%	14.3%	14.1%
Legs	23.1%	23.9%	23.1%
Trunk	25.3%	25.3%	25.3%
Total	22.3%	22.2%	22.40%

% Body Fat





VO₂ Max test

- All VO₂ max tests were performed at altitude
- Subjects were asked to continue running until they reached volitional fatigue
- Protocol

Test Time (min)	Stage Time (min)	Speed (mph)	Grade (%)	Position
0-1	1:00	0	0	Standing
2-3	2:00	2.0	0	Walking
4-5	2:00	7.0 m, 6.0 f	0	Running
6	1:00	7.0 m, 6.0 f	2	Running
7	1:00	7.0 m, 6.0 f	4	Running
8	1:00	7.0 m, 6.0 f	6	Running
9	1:00	7.0 m, 6.0 f	8	Running
10	1:00	7.0 m, 6.0 f	10	Running
11	1:00	7.0 m, 6.0 f	11	Running
12	1:00	7.0 m, 6.0 f	12	Running
13	1:00	7.0 m, 6.0 f	13	Running
14	1:00	7.0 m, 6.0 f	14	Running
End of Test	Until HR <120	2.0	0	Active Recovery



Max VO_2





Study Participants

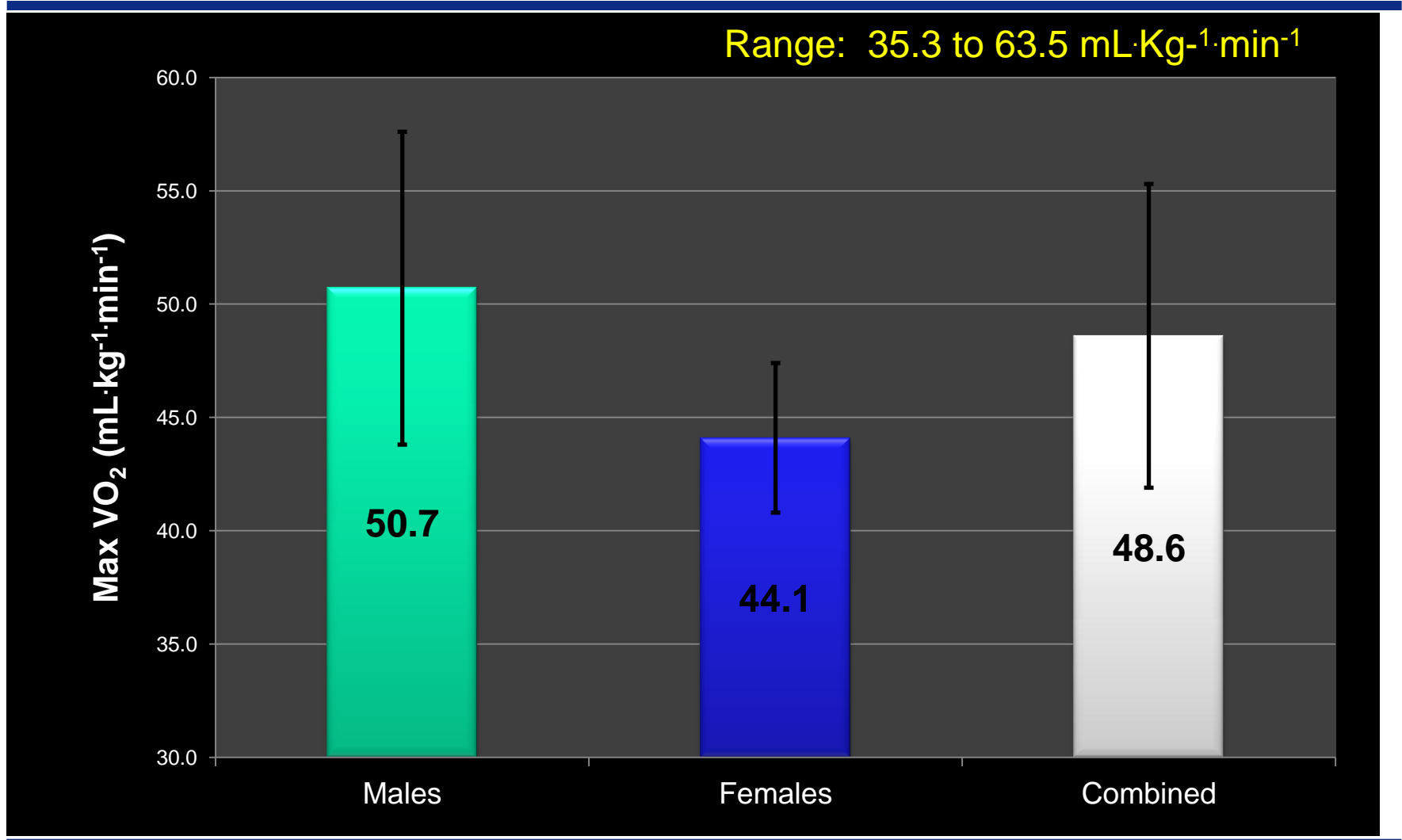
- Fifty-five, non smoking, male and female subjects signed informed consent documents (ICD) and completed DXA and VO_{2max} tests
- All subjects had to be living continuously in Colorado Springs for at least 6 weeks.
- Three subjects did not complete the 1.5 miles run tests due to AF commitments and non-study related injuries
- *Subjects demographics:*



	n	DXA (%BF)	Age (yrs)	Weight (lbs)	Height (in)
Males	38	16.4 ± 7.6	32.3 ± 6.5	173 ± 24	71.7 ± 3.1
Females	17	24.9 ± 4.7	33.6 ± 6.9	132 ± 18	64.7 ± 2.2
Total	55	19.0 ± 7.9	32.7 ± 6.6	160 ± 29	69.5 ± 4.4



Subjects Demographics (cont): VO₂ Max



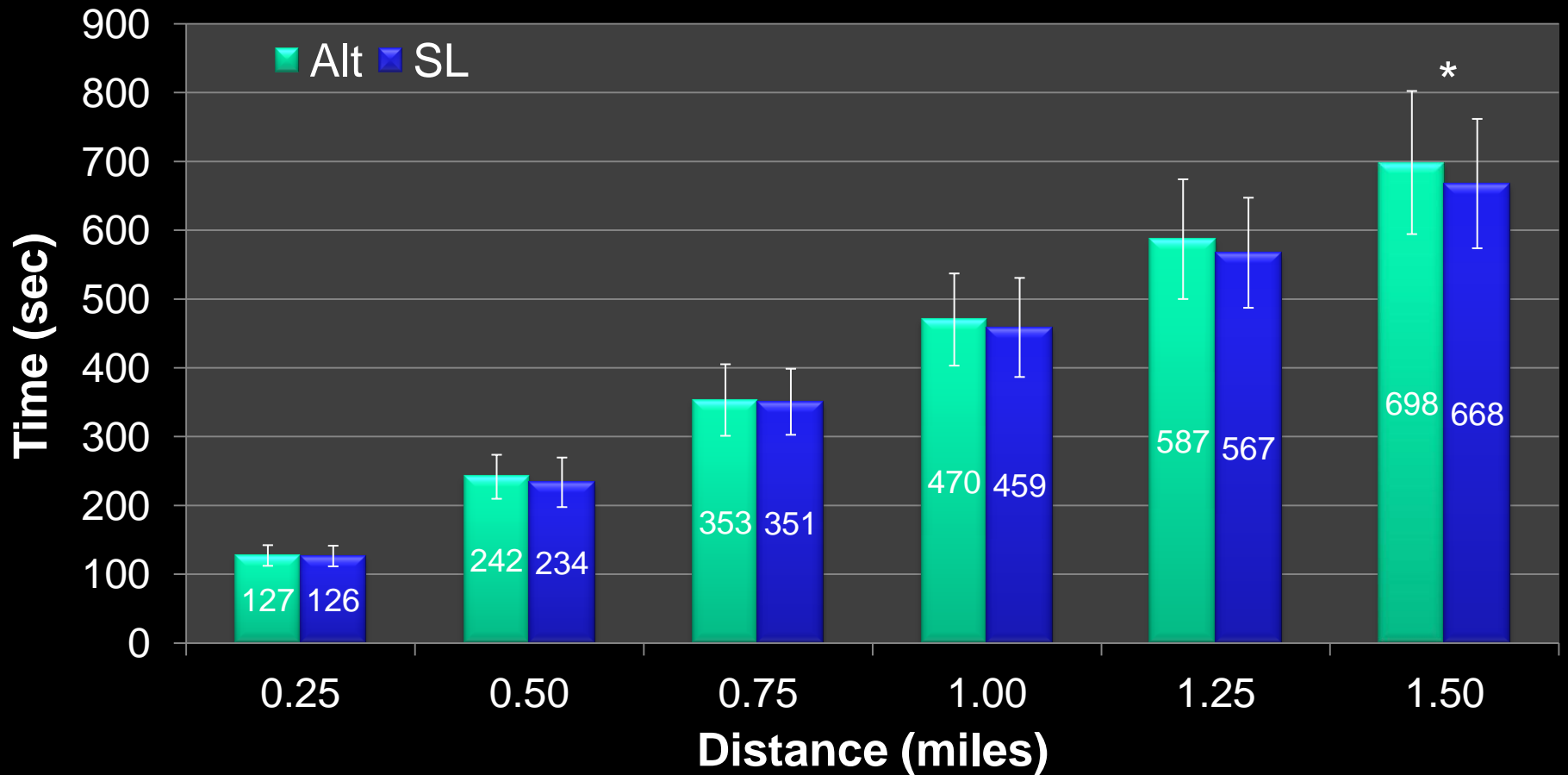


Results





1.5 Mile Run times at ALT and SL



* $p < 0.001$



Differences between ALT and SL run times



* $p < 0.001$

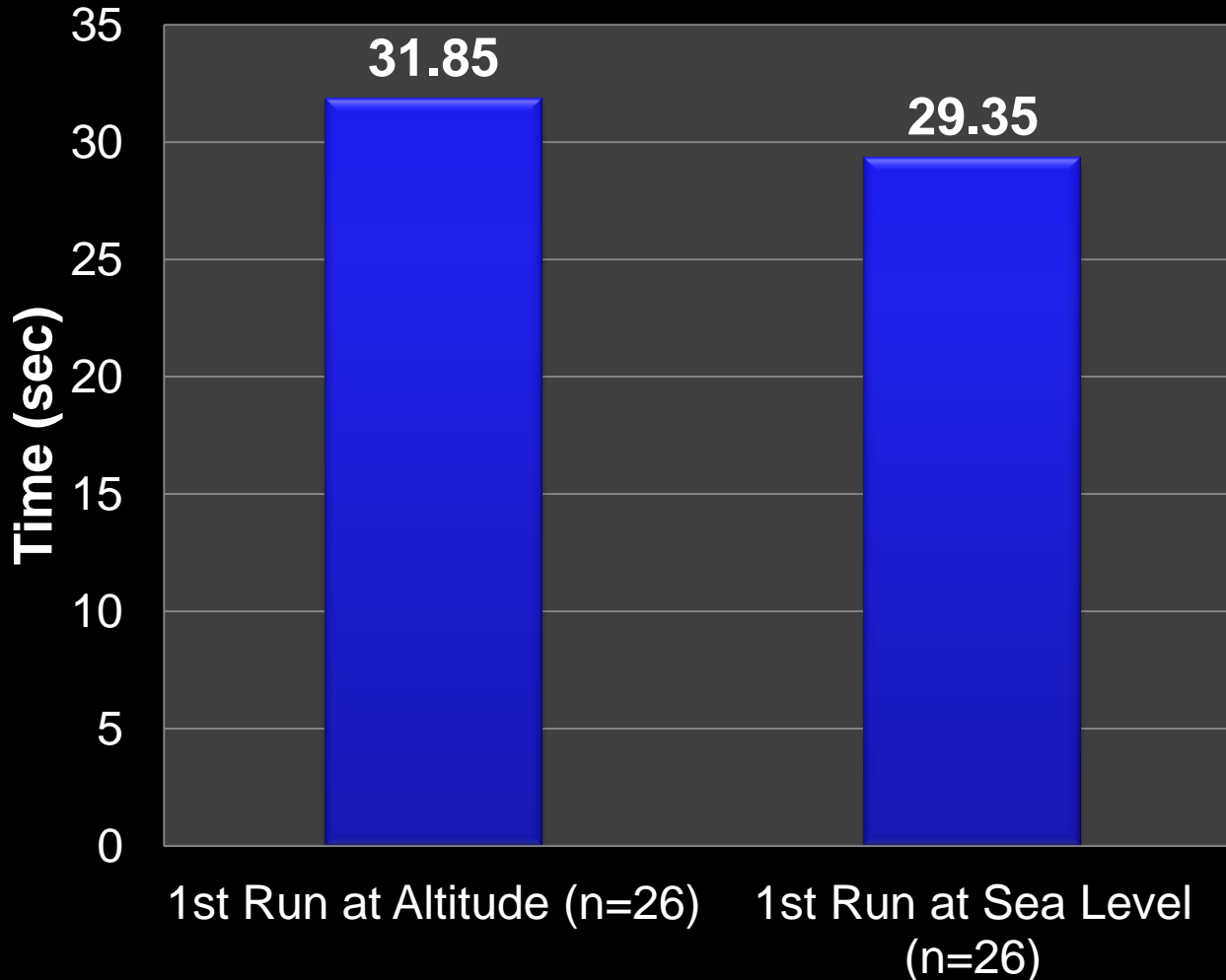


Rate of Perceived Exertion during 1.5 Mile Runs at ALT and SL



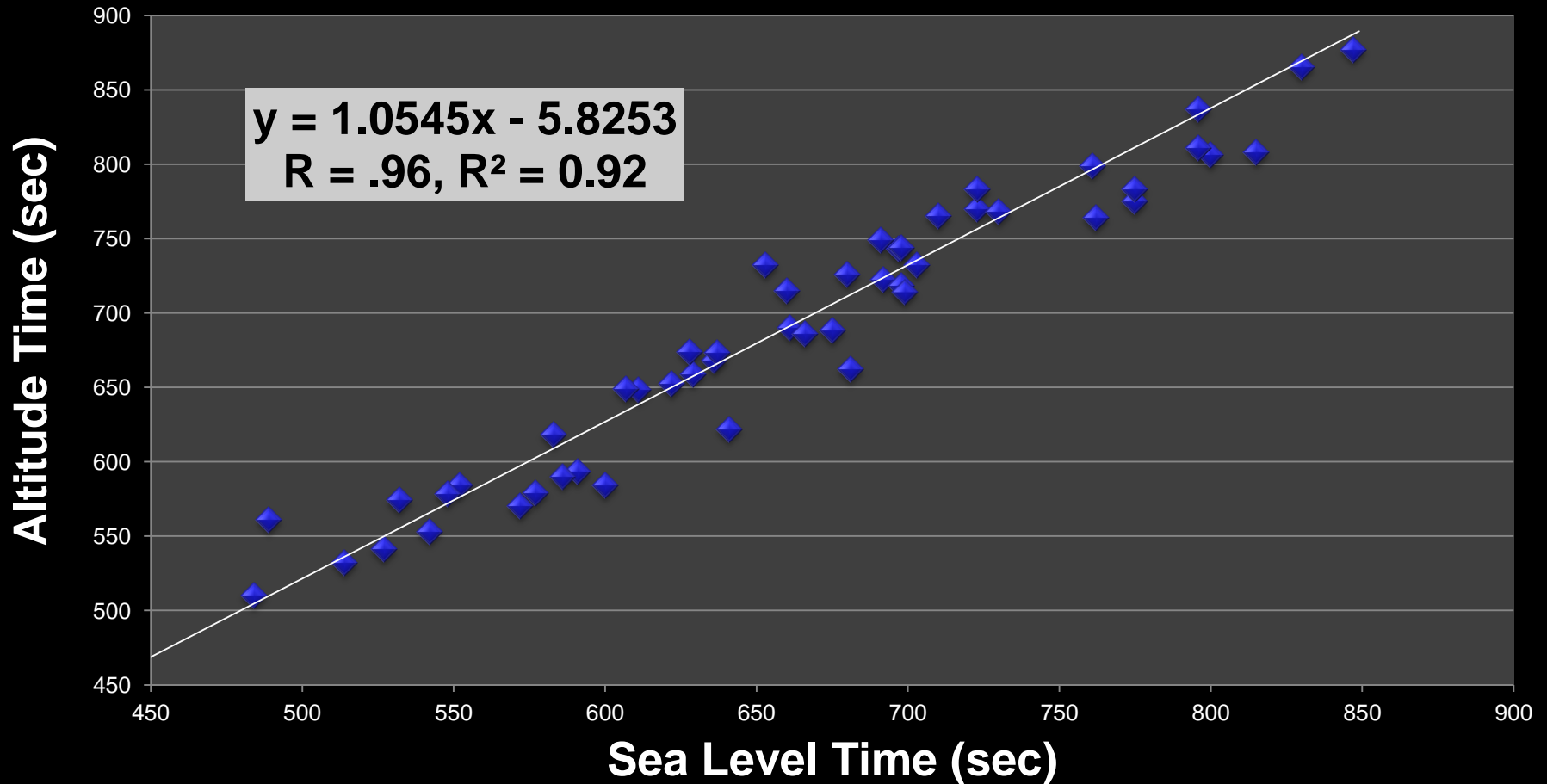


Differences seen with Randomization of 1.5 Mile Runs



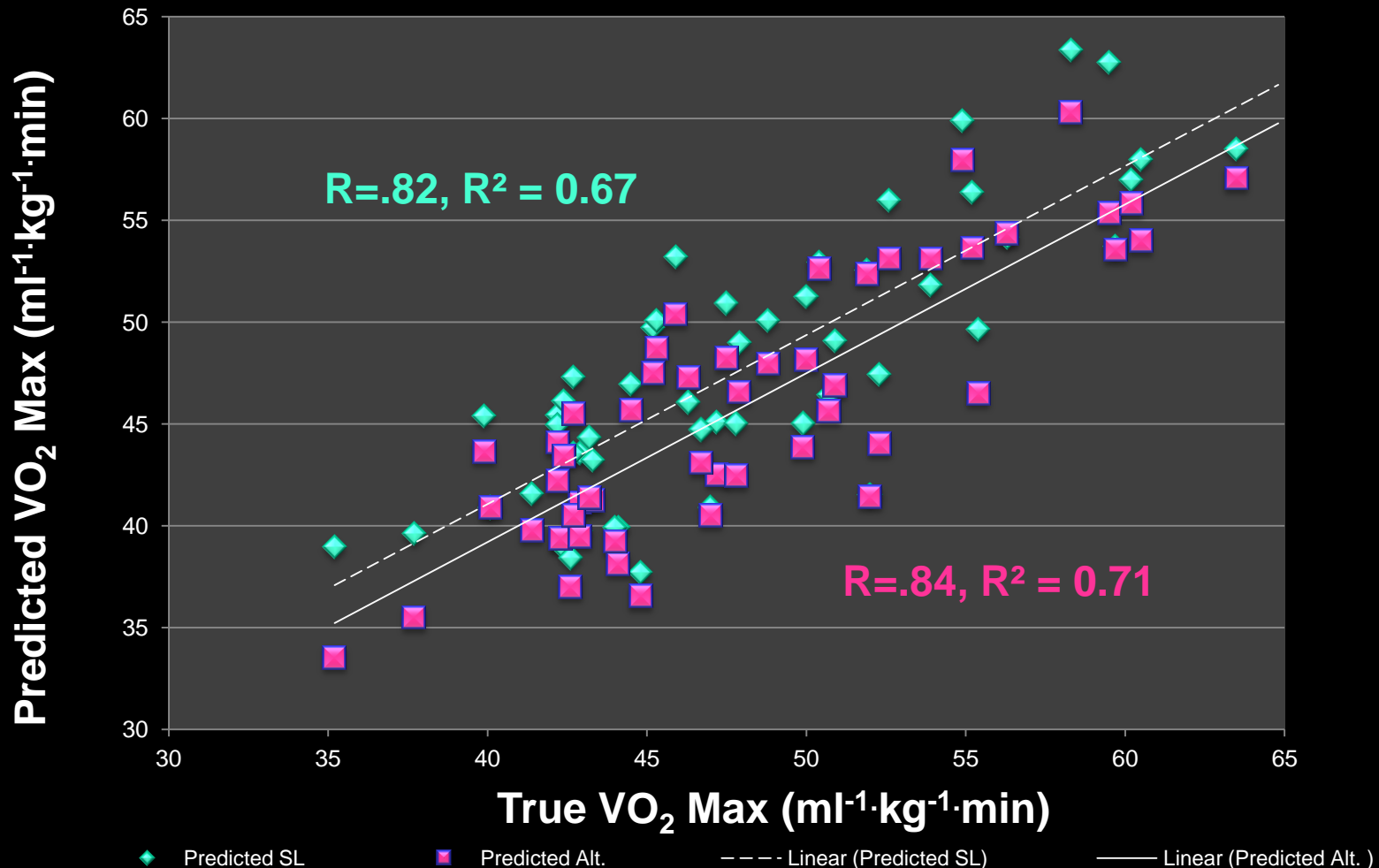


Comparison of run times at ALT and SL



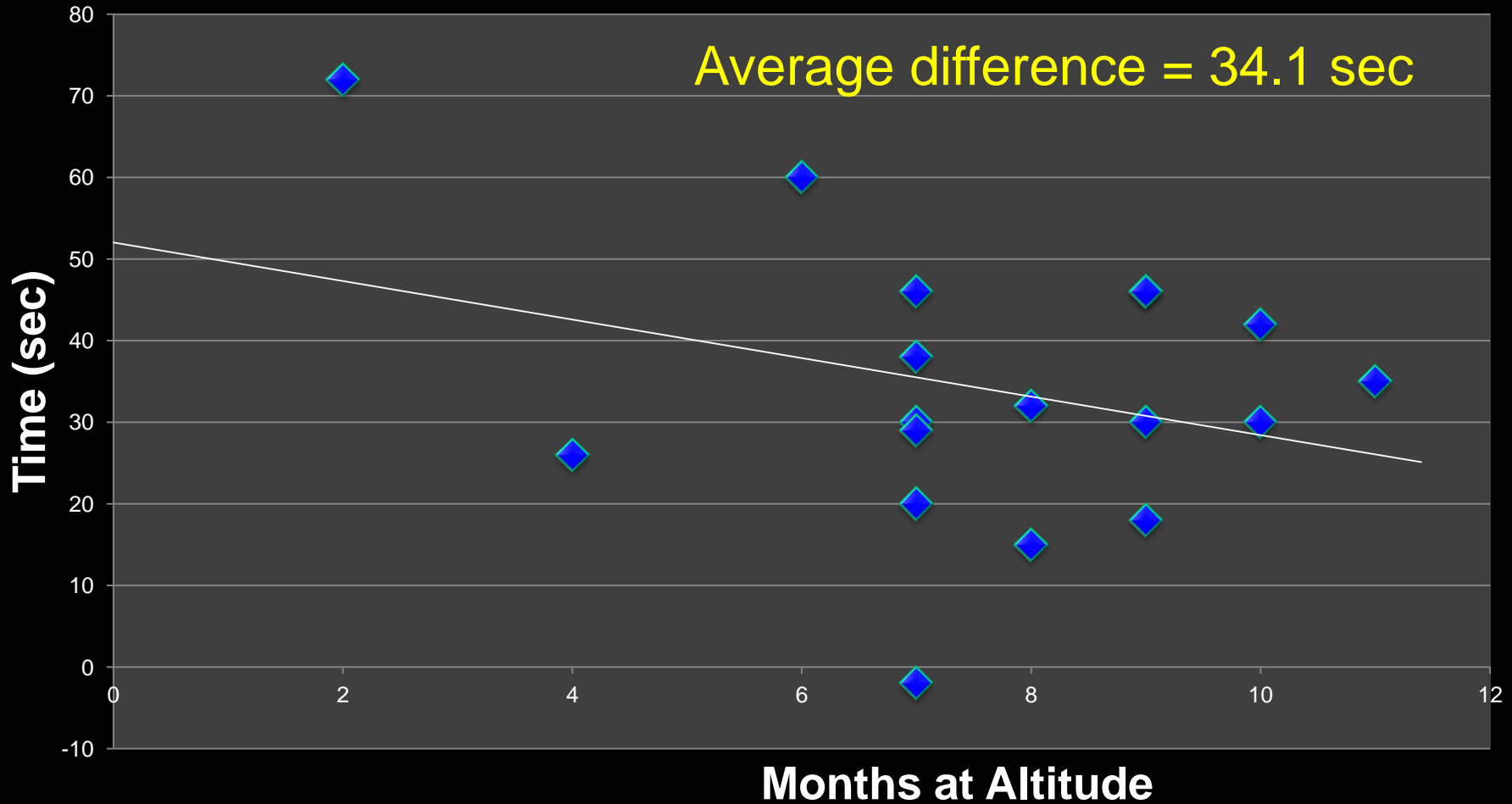


VO₂ Max vs. Predicted VO₂ at 850 and 7,200 Feet





Time Differences for Subjects (18) Living at Moderate Altitude <1 year



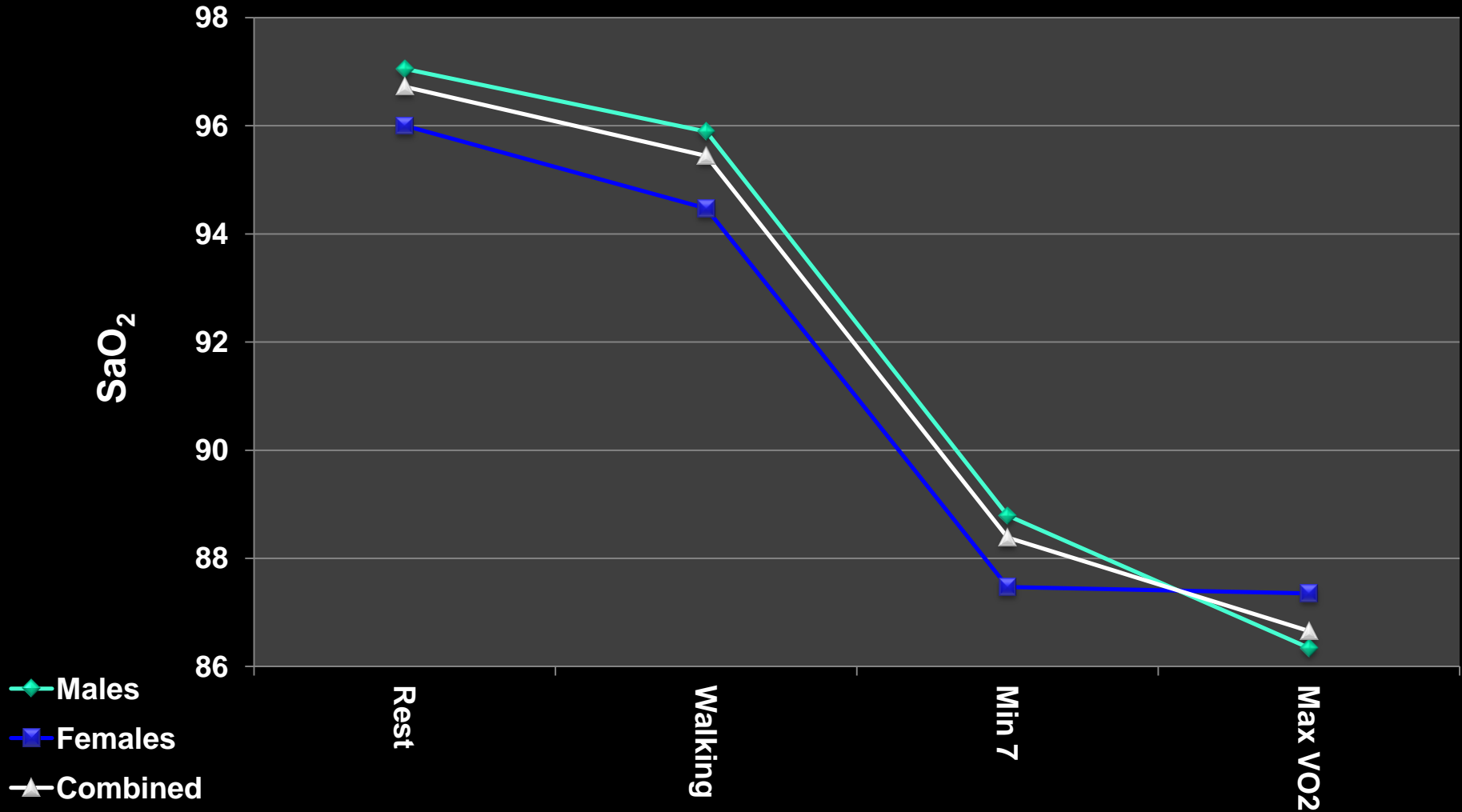


Heart Rates during 1.5 mile runs at ALT and SL



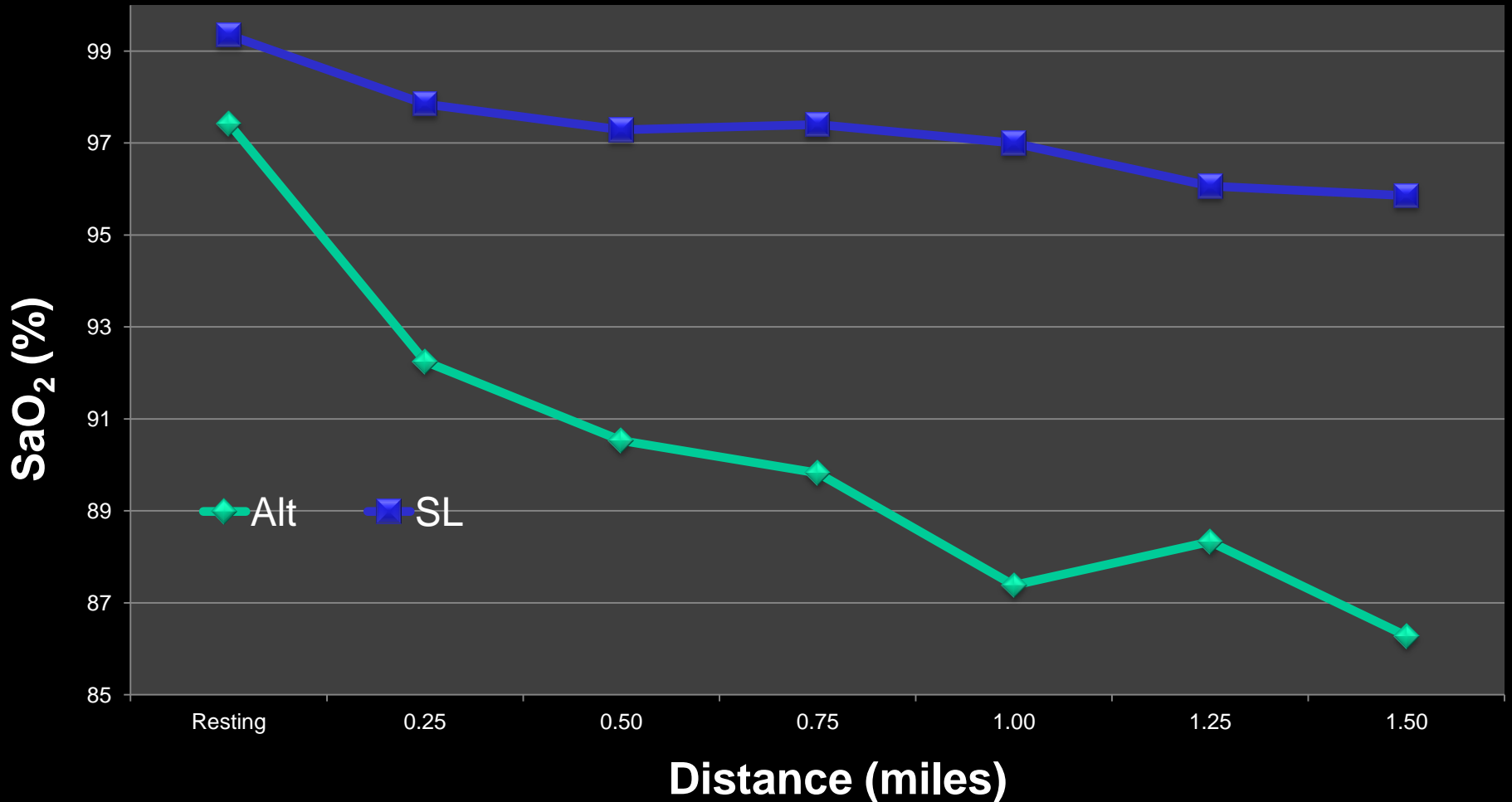


SaO₂ levels during the Max VO₂ test





Average SaO₂ During 1.5 Mile Runs





Conclusions

- A 30.6 seconds, or 4.2% decrease in 1.5 mile running times was measured when running at ~850 ft compared to 7,200 ft.
- These differences were mainly due to a decreased hemoglobin oxygen saturation associated with running at altitude with lower O₂ partial pressures.
- HR and RPE were not significantly different between runs
- Our recommendation is that an altitude adjustment for the Air Force fitness test be reinstated for airmen testing at moderate altitude bases.





Acknowledgments

I wish to acknowledge the help of the following individuals in data collection early analysis of the results.

Dustin R. Bakkie - Western State College

Jennifer A. Malagon - Colorado State University

Jessica A. Malagon - Colorado State University

Kristin Perdue - University of Northern Colorado

- **This work was supported by Air Force Medical Support Agency(AFMSA/SG9)**