Controversies in Strength Training Guidelines and Recommendations

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Background

- Of all of the disciplines/topics in Exercise Science, strength training clearly has the smallest empirical base of research support.
- Concerns over research-supported practice were raised in responses to the ACSM Position Stand.

American College of Sports Medicine. *Kraemer WJ. Position Stand: Progression models in resistance training for healthy adults.* ***Med Sci Sports Exerc*** *2002; 34: 364-380.*

- Identification of deficient research areas can stimulate needed research, and refine current strength training recommendations.

Ralph N. Carpinelli, Robert M. Otto, Richard A. Winett. *A Critical Analysis Of The Acsm Position Stand On Resistance Training: Insufficient Evidence To Support Recommended Training Protocols.* ***JEP****online* *2004;7(3):1-60*

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Strength Training Controversies

1. Machines vs. Free Weights

- Is one of either machines or free weights superior for strength, power or endurance?
- No.


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2. Short vs. Long Repetition Durations

- Are contactions that are < 1-2 s more effective than longer duration contractions in stimulating strength gains?
- No.


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3. Number of Repetitions

- Are 5-6 repetitions to failure/set superior for strength gains than sets with more repetitions?
- No. *Data suggest that gains are similar for 3 to 20 repetitions.*

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4. Number of Sets – Untrained Subjects

- Are strength gains larger when untrained subjects perform multiple sets?
- *Insufficient evidence! Most research reveals that 1 set is sufficient for optimal strength gains.*

5. Number of Sets – Resistance-Trained Subjects

- Do trained subjects need more sets?
- *No. Most research reveals that 1 set is sufficient for optimal strength gains, even for trained subjects.*

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6. Rest Interval Between Sets

- Does increasing rest between sets improve strength training adaptations?
- *Insufficient evidence!*

7. Exaggerating the Eccentric Component

- Is there an added benefit to training when only doing the eccentric component of a muscle action?
- *No!*

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8. Number of sessions/week

- Is an increased frequency of training above 3/week beneficial for improved strength gains?
- *Although a seemingly logical recommendation, there is no research support for this belief, not even for highly trained athletes!*

9. Split Routines

- Does the use of split routines to increase training volume increase strength gains?
- *Although a popular practice, there is no research support for split routines, not even for highly trained athletes!*

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10. Periodization in Training

- Do greater strength gains result from application of periodization principles in a long-term training program?
- *No research evidence!*

11. High Repetitions and Muscular Endurance

- Does muscular endurance increase more when performing training with high repetitions?
- *No research evidence!*

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12. Explosive Multiple Set Lifting

- Does muscular power increase more when performing rapid or explosive contractions over multiple sets?
- *No research evidence!*

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13. Hypertrophy

- Is muscle hypertrophy increased more with high resistance and volume training?
- *No research evidence!*

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Recommended Research Topics In Resistance Exercise and Training

- Machines vs. Free Weights
- Number of repetitions/set
- Number of sets/session
- Velocity of muscle contractions
- Explosive contractions for muscular power
- Optimal recovery between sets

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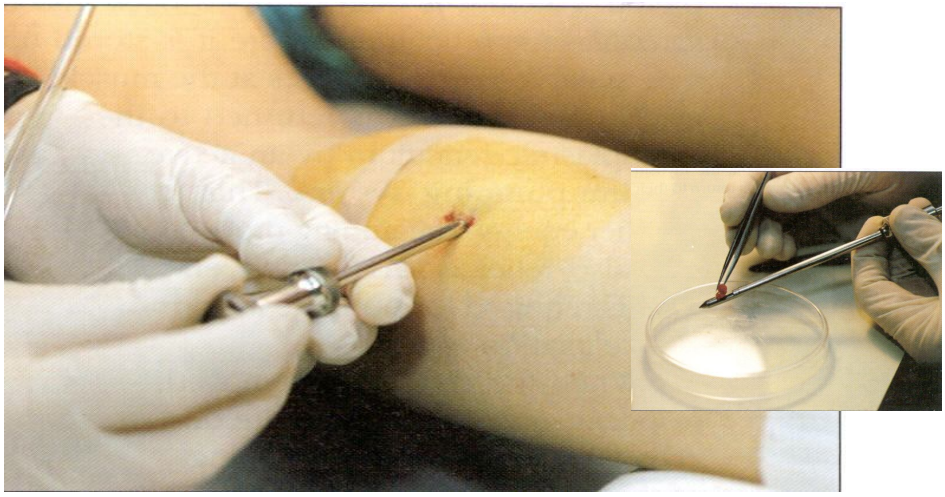
Hypertrophy vs. Hyperplasia?????



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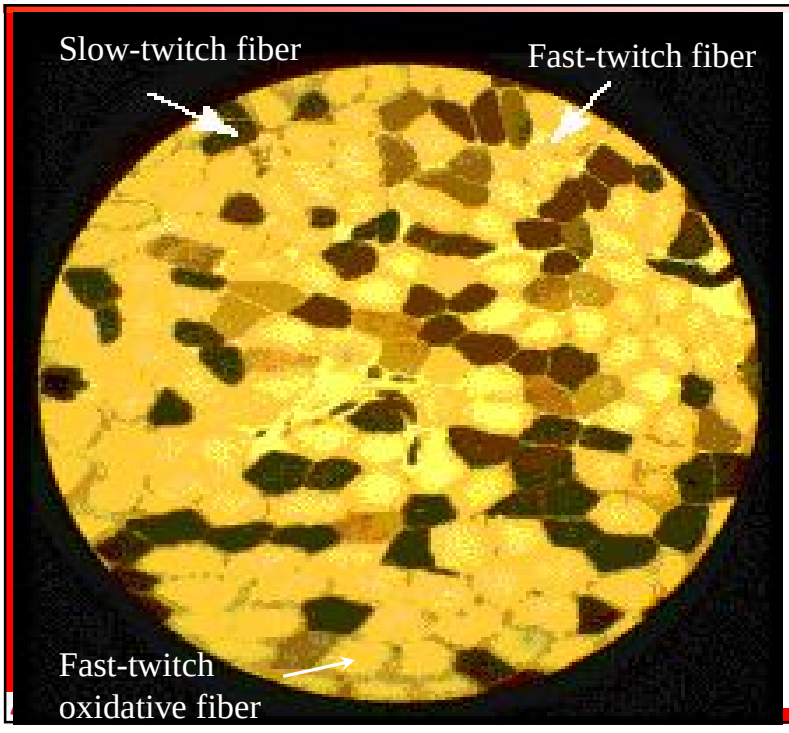
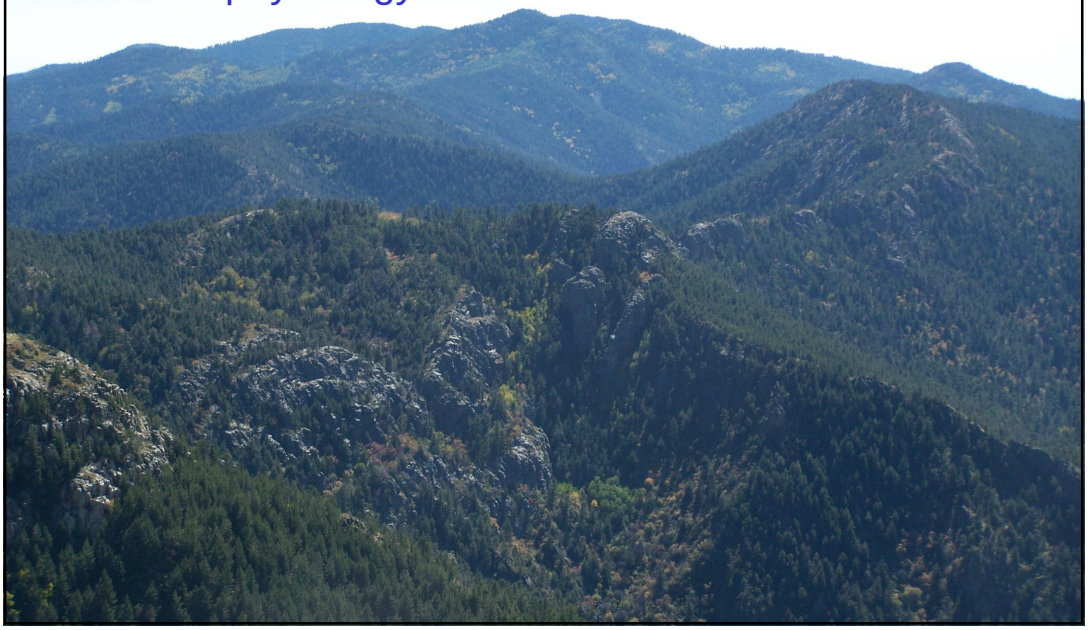


Hyperplasia probably occurs in serious body builders, but we cannot detect it in humans

myosin-ATPase stain

preincubation pH=4.6

- What have we done at UNM to contribute to the exercise physiology of resistance exercise?



Recent Research From UNM

What is the decrement in strength as RM Increases?

Can we more accurately predict 1RM strength from multiple RM tests?

70 subjects (34 men, 36 women)

1, 5, 10 and 20 RM Testing for Chest Press and Leg Press

We graphed strength decrement across RM values

We calculated 1 RM from 5, 10 and 20 RM tests

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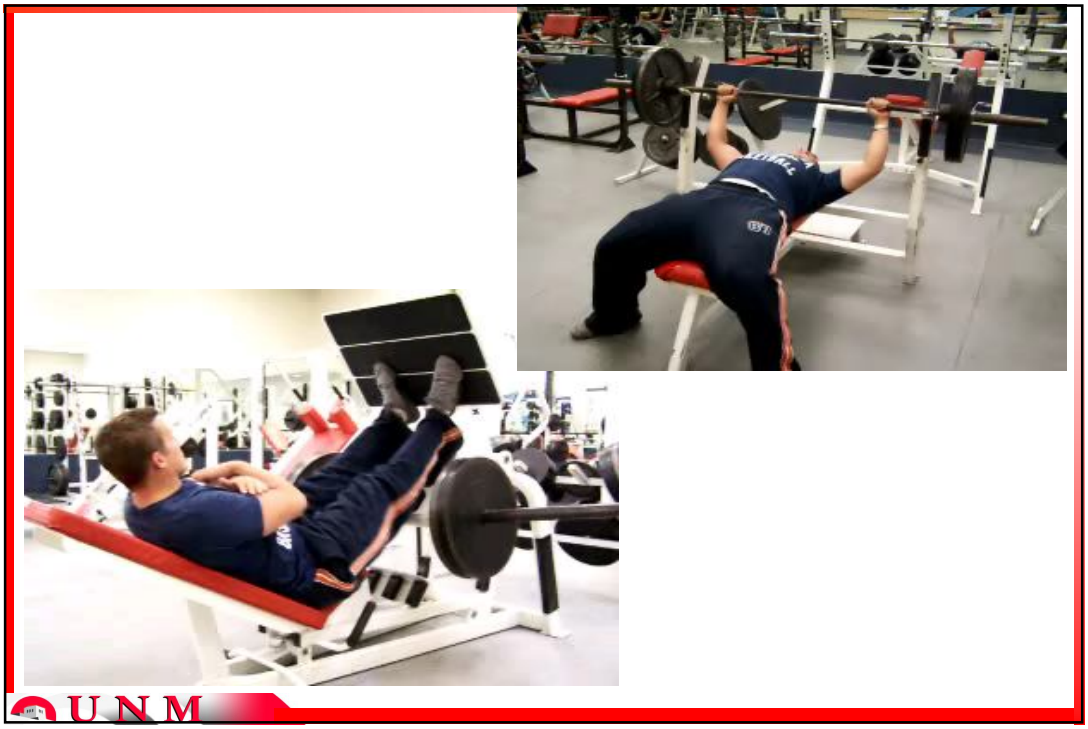
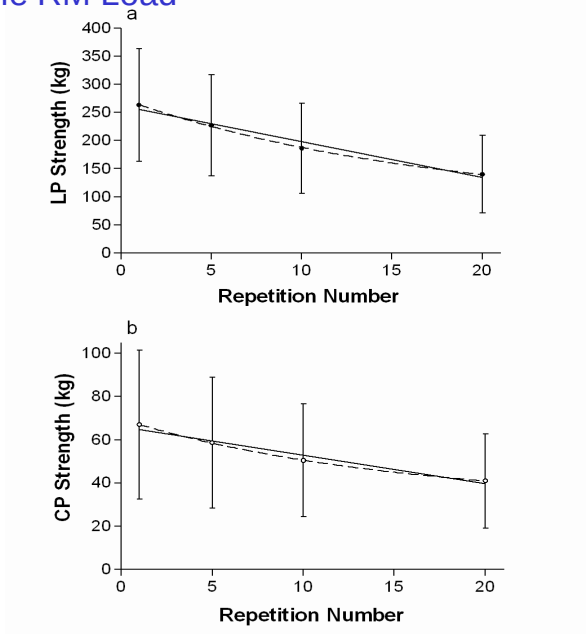
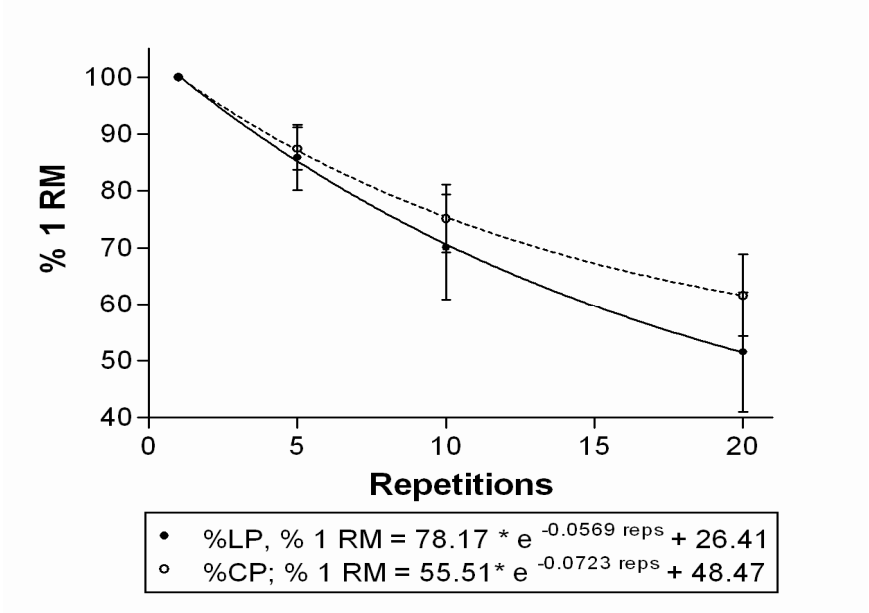


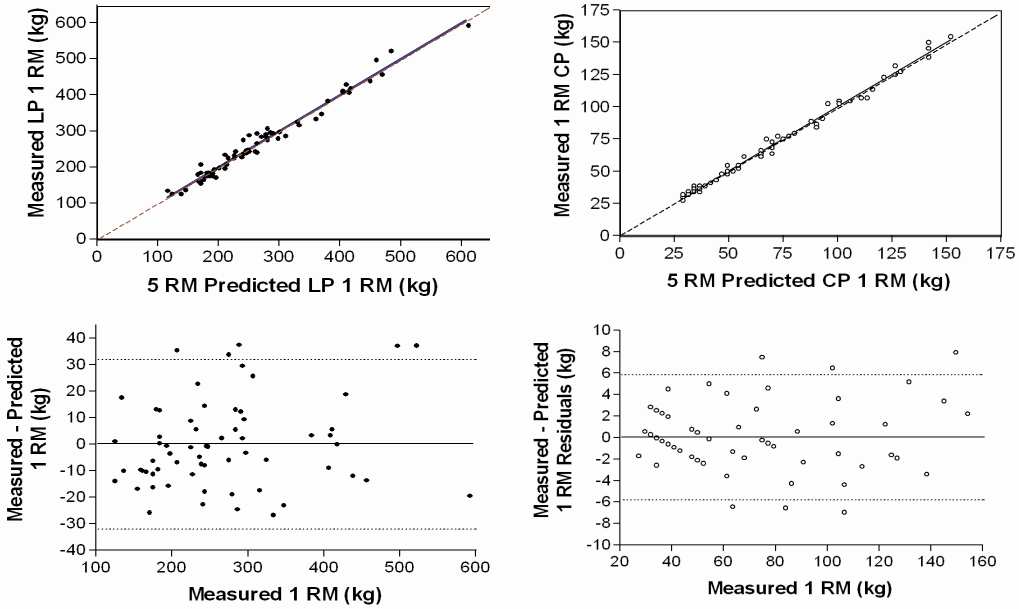
Estimating Multiple RM Load



Estimating Multiple RM Load



1 RM Prediction from 5 RM



Conclusions

- Leg Press 5 RM = 85.91% 1RM
  10 RM = 70.1% 1RM
  20 RM = 51.6 % 1RM
- Chest Press 5 RM = 87.45 % 1 RM
  10 RM = 75.65 % 1 RM
  20 RM = 61.61 % 1 RM

- Multiple regression to predict 1 RM most accurate from 5 RM test

Leg Press 1 RM (kg) = (1.09703 x 5 RM kg) + 14.2546

Chest Press 1 RM (kg) = (1.1307 x 5 RM kg) + 0.6998

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Recent Research From UNM

Can we more accurately estimate energy expenditure during strength training?

If so, what is this energy expenditure for a given load and distance the load is lifted?

43 male subjects (23 for chest press, 20 for parallel squat)

In Press: Journal Strength and Conditioning Research. 2006

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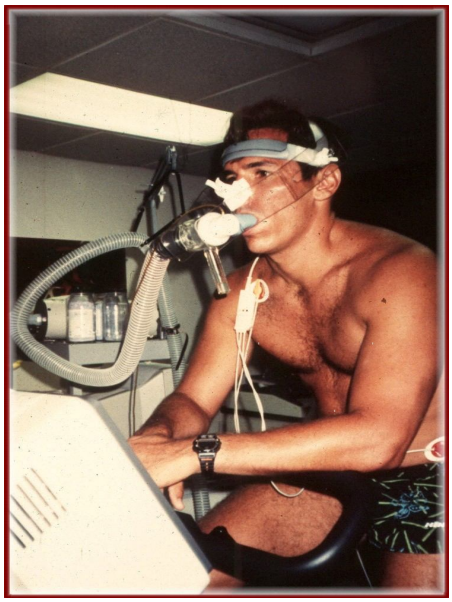
Problem



RQ	kcal/L O_2	% CHO*	kcal/L O_2 CHO	% FAT	kcal/L O_2 FAT
1.00	5.047	100.00	5.047	0.0	0.000
0.99	5.035	96.80	4.874	3.18	0.160
0.98	5.022	93.60	4.701	6.37	0.230
0.97	5.010	90.40	4.529	9.58	0.480
0.96	4.998	87.20	4.358	12.80	0.640
0.95	4.985	84.00	4.187	16.00	0.798
0.94	4.973	80.70	4.013	19.30	0.960
0.93	4.961	77.40	3.840	22.60	1.121
0.92	4.948	74.10	3.666	25.90	1.281
0.91	4.936	70.80	3.495	29.20	1.441
0.90	4.924	67.50	3.324	32.50	1.600
0.89	4.911	64.20	3.153	35.80	1.758
0.88	4.899	60.80	2.979	39.20	1.920
0.87	4.887	57.50	2.810	42.50	2.077
0.86	4.875	54.10	2.637	45.90	2.238
0.85	4.862	50.70	2.465	49.30	2.397
0.84	4.850	47.20	2.289	52.80	2.561
0.83	4.838	43.80	2.119	56.20	2.719
0.82	4.825	40.30	1.944	59.70	2.880
0.81	4.813	36.90	1.776	63.10	3.037
0.80	4.801	33.40	1.603	66.60	3.197
0.79	4.788	29.90	1.432	70.10	3.356
0.78	4.776	26.30	1.256	73.70	3.520
0.77	4.764	22.30	1.062	77.20	3.678
0.76	4.751	19.20	0.912	80.80	3.839
0.75	4.739	15.60	0.739	84.40	4.000
0.74	4.727	12.00	0.567	88.00	4.160
0.73	4.714	8.40	0.396	91.60	4.318
0.72	4.702	4.76	0.224	95.20	4.476
0.71	4.690	1.10	0.052	98.90	4.638
0.707	4.686	0.0	0.000	100.00	4.686

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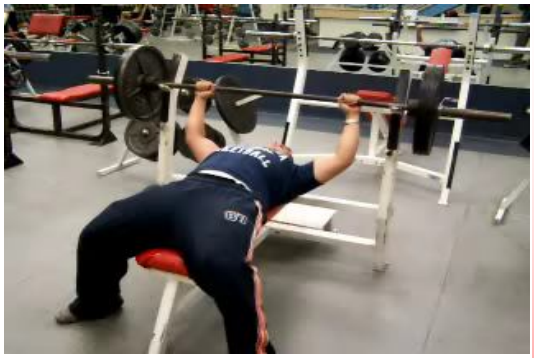

Expired gas analysis indirect calorimetry

Accounted for body weight in load lifted

Measured vertical distance the load was lifted

Computed power and work

Used load and distance in multiple regression to predict VO_2

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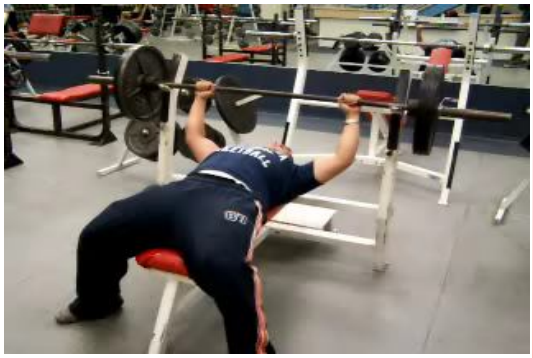

Steady State VO_2 measured for multiple intensities

Linear Regression used to extrapolate VO_2 to heavy loads

VO_2 converted to Kcals/min

Compared Kcals to previously published data.

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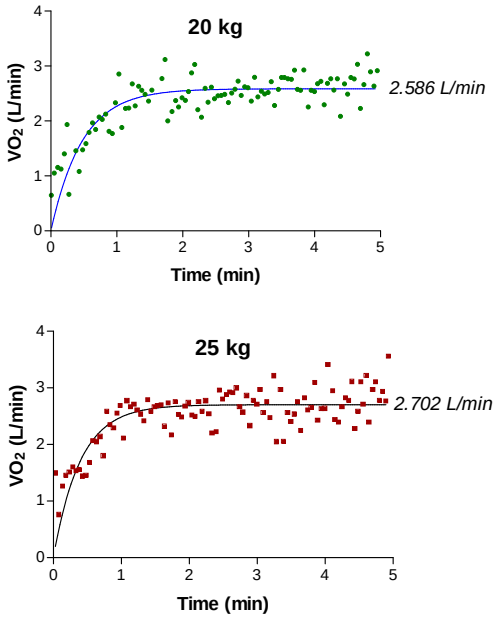
Sample Data



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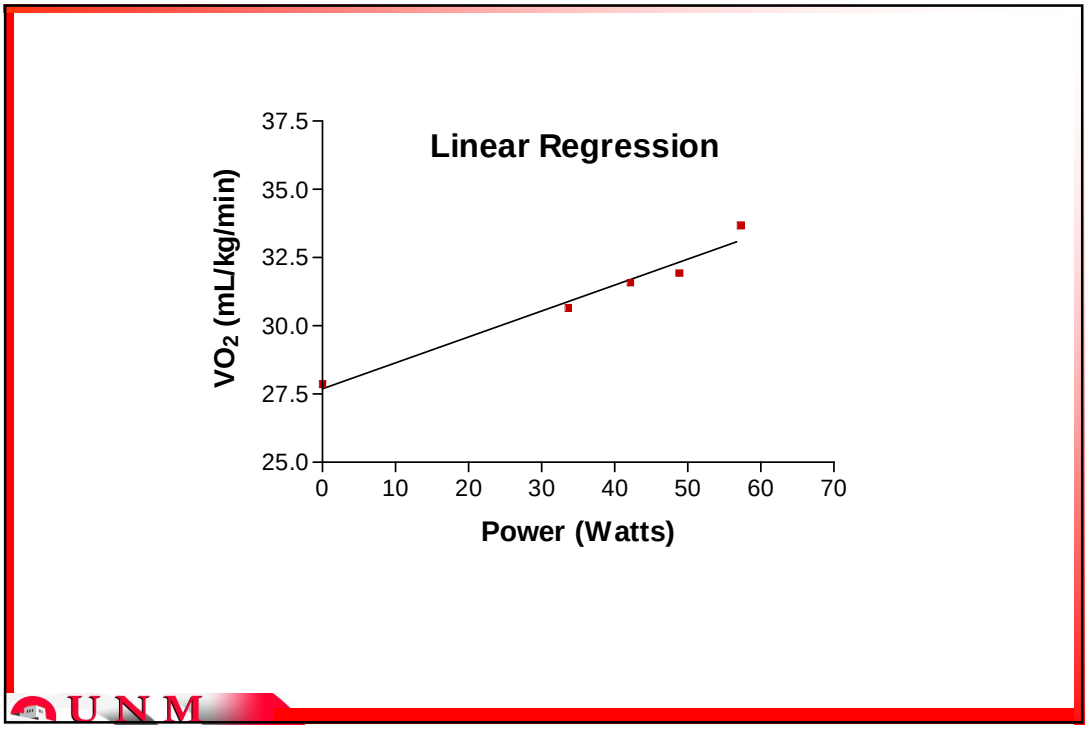
Linear Regression
VO_2 (mL/kg/min)
37.5
35.0
32.5
30.0
27.5
25.0
0
10
20
30
40
50
60
70
Power (Watts)
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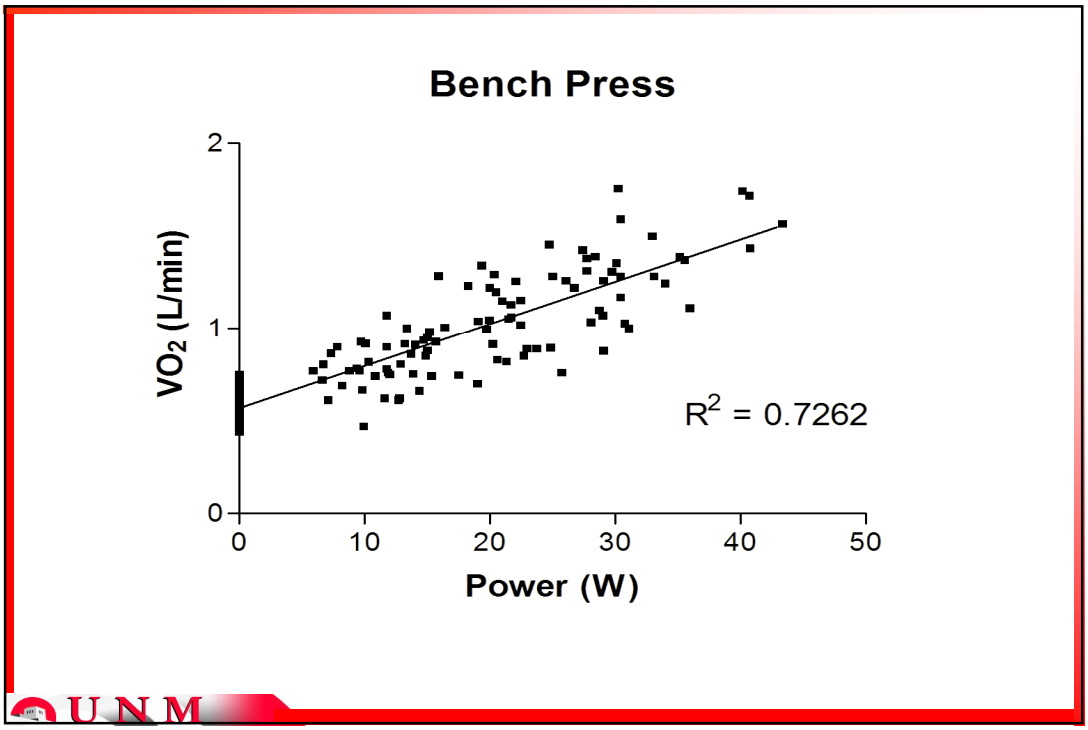
Bench Press
VO_2 (L/min)
2
1
0
R^2 = 0.7262
0
10
20
30
40
50
Power (W)
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Conclusions

- Chest Press VO_2 = 0.132 + (0.031 * kg load) + (0.01 * cm lifted)
- Parallel Squat VO_2 = -1.421 + (0.022 * kg load) + (0.035 * cm lifted)
- Kcals = VO_2 *L/min* x 5.05 *Kcals/L* x distance *cm* x repetitions
- Energy expenditure 2 to 3 times higher than prior research!
- Supports observations and logic for high energy demands of resistance exercise.

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