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Effects of aerobic and resistance exercise on hunger and energy intake in young physically active adults

Derek Laan

Purdue University - Main Campus, dlaan@purdue.edu

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Effects of aerobic and resistance exercise on hunger and energy intake in
young physically active adults

By

Derek Laan

A Thesis Submitted in Partial Fulfillment
Of the Requirements for a Degree with Honors
(Dietetics and Nutrition, Fitness and Health)

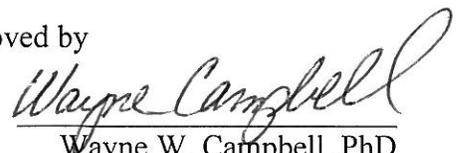
The College of Consumer and Family Sciences

Purdue University

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West Lafayette, Indiana

Approved by



Wayne W. Campbell, PhD
Honors Adviser

Abstract

Background: Aerobic exercise (AEx) has been shown to induce a transient anorexia of exercise. The impact of AEx on hunger and energy intake is controversial. The effects of resistance exercise (REx) on appetite and energy intake are undocumented. **Methods:** Nineteen young, fit adults (9M, 10F; age 22 ± 1 y; VO_{2max} 55.9 ± 3.0 ml \cdot kg $^{-1}\cdot$ min $^{-1}$) completed duplicate sessions of: AEx (35 min of cycling at 70% heart rate reserve); REx (35 min, 3 sets at 70% one rep max for five exercises); and no exercise (CON). Perceived hunger was assessed throughout each session. 30 min post-Ex a pasta meal was consumed ad libitum. Total (TEI) and relative (REI) energy intakes were determined [REI = TEI - energy expenditure of exercise (EEEx)]. **Results:** Hunger was reduced immediately after AEx and returned to CON levels 30 min later, whereas the hunger response after REx was not different than CON (session effect $p<0.05$). TEI of the pasta meal was higher after AEx and REx than control (897 ± 96 , 928 ± 94 , 784 ± 89 kcal, respectively; session effect $p<0.05$). The estimated EEEx of AEx and REx differed (290 ± 7 vs. 80 ± 2 kcal, $p<0.05$). REI was lower after AEx than REx and CON (607 ± 94 , 848 ± 94 , 784 ± 89 kcal, $p<0.05$). **Conclusion:** The description that AEx induces anorexia of exercise is not consistent with the increased TEI, but reflects the transient decrease in hunger and lower REI attributable to the EEEx. REx stimulates energy intake and does not induce anorexia of exercise.

Key Words: Appetite, Energy Intake, Exercise, Hunger, Strength Exercise

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INTRODUCTION

Exercise is an important component of a weight management program. High intensity aerobic exercise ($>60\%$ VO_{2max}) has been found to alter hunger and food intake (1, 2). Specifically, Verger and colleagues measured appetite and food intake in 13 college-age subjects at 0, 30, 60, and 120 minutes following a high intensity exercise session. Hunger and food intake were reduced at 0 and 30 minutes post-exercise compared to 60 and 120 minutes post-exercise (3). This suggests that exercise leads to suppressed feelings of hunger and a delay in food intake. However, this effect, known as the anorexia of exercise, has been shown to disappear somewhere between 30 and 60 minutes after exercise and has not yet been studied using resistance exercise (3, 4).

While anorexia of exercise is one appetitive effect, many studies have also found that there is not a strong dietary compensation for the energy expended during exercise (3-11). Previous studies have assessed dietary compensation by comparing Relative Energy Intake (REI) or the energy intake (EI) of a meal minus the energy expenditure of exercise (EEx) for an exercise variable and a no exercise control. Maraki and colleagues compared the effects of a 1-hr exercise class with the effect of no exercise on acute food intake and found no difference in total intake. However because of the EEx there was a lower REI with the exercise group (12). These studies documented a short-term suppression of appetite and decreased REI with aerobic exercise but few have examined the influence of resistance exercise. Many studies looked to evaluate the effects of exercise on appetite and food intake over longer periods of time.

Durrant et al. found that exercise led to lower 24-h energy intake compared to no exercise in lean and obese subjects(13). Dickson-Parnell and Zeichner found that women consumed significantly less food on days when they exercised over a 7-week period where they exercised 3

times per week compared to a control of no exercise over the same period (14). But it is important to note that regular exercisers typically compensate well for the exercise that they do regularly but when they do more or less exercise they don't compensate for it immediately. McGowan and colleagues studied 7 male joggers by having them either run none, regular or double their weekly miles for one week. When their weekly running mileage was doubled EI only increased by about 150 kcal/d and when they were forced to rest for a week their EI only decreased marginally (15). These studies suggest that exercise, which leads to increased energy expenditure, does not lead to immediate dietary compensation.

While most of the previously mentioned studies have documented the anorexic effect of exercise (i.e., reduced hunger and food intake) along with the lack of complete short term dietary compensation following high intensity aerobic exercise, few studies to date have evaluated the effect of resistance training on appetite and food intake. Broom DR and colleagues found a similar suppression of hunger with resistance and aerobic exercise but did not evaluate food intake (16). The present study evaluated the appetitive and dietary intake responses to resistance exercise, and compared these responses with those of aerobic exercise.

SUBJECTS AND METHODS

Subjects

Twenty-nine individuals from the Purdue University Community were recruited using flyers. The subjects were male or female age 18-29 y, physically active participating in at least 2 aerobic exercise and 2 resistance exercise sessions of at least 30 minutes each per week for the last 3 months. Inclusion criteria included a BMI between 18-29 kg/m², percent body fat less than 20% for males and 35% for females, stable weight (less than 4.5 kg loss or gain in past 6 months), non-smoking and acceptance of study food (pasta salad). Before participating, each subject completed a medical history questionnaire, and was approved by the study physician and before giving informed consent. The study was approved by the Purdue University Institutional Review Board and the subjects received monetary compensation for participating. Twenty-nine subjects began and 19 subjects completed the protocol; 10 women and 9 men all Caucasian. Ten subjects dropped out due to lack of interest or commitment to follow protocol tasks. Subject characteristics are presented in Table 1.

Baseline Assessments

Strength, aerobic fitness and body composition were measured at the start of the study. Body fat % was estimated from body volume and mass measured using plethysmography (BOD-POD, Life Measurement Instruments, Inc., Concord, CA) and the Siri two-compartment model equation (reference). Height was measured with subjects standing barefoot using a wall-mounted stadiometer. Maximum strength (one repetition maximum) for chest press, double leg press, seated row, leg extension and leg curl exercises was assessed using pneumatic resistance exercise equipment (Keiser Sports Health Equipment Company, Fresno, CA). The YMCA sub

maximal cycle ergometry protocol was used to estimate each subject's maximum oxygen consumption ($\text{VO}_2 \text{ max}$) (ACSM 2006). Monark Cycle Ergometers (Ergomedic 828E, Monark Exercise AB, Sweden) and Polar heart rate monitors (A1, Polar Electro Oy, Finland) were used for the protocol. Subjects were weighed using a scale which was calibrated to within 5 grams of actual weight.

Experimental Design and Procedures

This randomized cross-over study used a within-subject design with three treatments (aerobic exercise (AEx); resistance exercise (REx); and no exercise control (CON) each performed in duplicate (6 trials total). The duplicate testing days for each treatment were performed consecutively with at least two days between sessions.

On each testing day, subjects were instructed to eat 3 hours prior to coming in for a testing session. Figure 1 shows the schedule of each testing day. Each subject also completed hourly appetite questionnaires and diet records during the day of and following each session.

Subjects reported to the laboratory during the afternoon and were asked to give a urine sample. Nude body weight was then taken and subjects began one of three 45-minute treatments:

AEx - 35 minutes of peddling on a cycle ergometer at 70 % Heart Rate Reserve with 5 minutes given for warm up and cool down.

REx - Weight lifting session of 3 sets of 8-10 repetitions of chest press, double leg press, seated leg extension, seated leg curl, and seated row with 1 minute of rest between each set and the third set being done to voluntary fatigue or 12 repetitions.

CON - Subjects were seated and were allowed to read, watch TV, or work on school work.

Appetite

Following the session, subjects immediately completed an appetite questionnaire. The questionnaire assessed Hunger, Fullness and Thirst using a visual analog scale and a 13 point rating system. Subjects completed one questionnaire every 15 minutes for 1 hour after completion of exercise as well as hourly questionnaires through out the remainder of the testing day and during the following day.

Energy Intake

Thirty minutes following the exercise treatment, the subject was served a large bowl of pasta salad and instructed to eat until they felt comfortably full. The subjects were seated at the same table but barriers were used so that they could not see each other. The subjects were supervised while eating and discouraged from socializing during the meal. Subjects were given 30 minutes to eat and consume 237 mL of water with the meal. The bowl with the pasta and the utensils were weighed before and after the meal to measure how much was consumed. The pasta salad was made with Barilla Tri Color Rotini, Kraft Light Done Right Italian dressing, and Kraft shredded parmesan cheese. Table 2 contains the macronutrient composition of the pasta salad.

Energy Expenditure

Energy Expenditure of Exercise (EEEx) was calculated using two separate methods for aerobic and resistance exercise. Metabolic Equivalents (METs) were used to calculate the EEEx for AEx (ACSM, 2006). A value of 8 was used for the METs which was used to determine energy expenditure (EE) per minute of AEx. The EEEx for REx was calculated using the following equation: $(35 \text{ min} \times \text{body weight (kg)} \times 0.141) / 4.184$ (Campbell et al, 1994). The EE

of the control was considered 0 for the purpose of the experiment and the EEEx for REx and AEx were adjusted to take out the resting EE.

Water Balance

Immediately before and within 5 minutes of finishing the treatment subjects nude weight was taken. This was used to measure water loss from the treatment. Conditions in the exercise room remained constant (21.3 degrees Celsius, 25% humidity) for each trial. 354 mL of water was consumed by each subject during each session. Subjects consumed 237 mL of water during the pasta meal. Following the meal subjects were given water ad libitum which was measured. The sum of the amount of water taken in and the weight lost during each treatment were used to assess water balance.

Statistical Analysis

SPSS 16.0 for Windows was used for all statistical analysis. All values in tables are reported as mean \pm Standard error of the mean. Results within treatments were not statistically different. Each subjects' results from within a treatment were averaged. One way Anova's were used to measure effects of the exercise on food intake, hunger, fullness, thirst, water loss, and water intake. Post hoc analysis was performed using LSD to compare effects of the different exercise types to each other.

RESULTS

Subject Characteristics

All subjects met the study inclusion criteria and their characteristics are outlined in Table 1.

Exercise

All subjects were able to successfully complete both exercise treatments in accordance with the guidelines in the methods. The subjects averaged 70.2 ± 0.7 % of their heart rate reserve for the 35 minutes of cycling during AEx, which equaled 80.7 ± 0.6 % of VO_{2max} . The average amounts lifted during the resistance exercise trial can be found in Table 3.

Acute Food Intake Response

Thirty minutes after REx and AEx acute food intake was higher for REx (18% higher than CON) and AEx (14% higher than control) compared to CON, with no difference in response between REx and AEx (CON 784 ± 89 Kcal, AEx 897 ± 96 Kcal, REx 924 ± 95 Kcal).

Total Food Intake

Two-day energy intakes were not significantly different between the trials for the group as a whole (Table 4). There was also no effect of exercise on the macro nutrient composition of the subjects' diet.

Acute Appetite Response

Immediately following both AEx and REx hunger was significantly lower than after the CON (5.5 ± 3.7 vs. 6.7 ± 3.4 vs. 8.2 ± 3.1 arbitrary units). Hunger gradually increased from 0

min after exercise until the meal was served at 30 minutes after exercise (Figure 2). AEx elicited a decrease in hunger while CON and REx caused a slight increase. AEx also produced the greatest increase in hunger from the end of the exercise to just before the meal (Figure 2). Fullness was greatest immediately after REx (3.3 ± 2.8 vs. 4.0 ± 3.1 vs. 2.8 ± 2.7) and decreased gradually until the meal was consumed (Figure 3).

Long Term Appetite

No significant difference for total Area Under the Curve (AUC) was found between the trials for Hunger, Fullness or Thirst over the 2 days for each trial they were recorded (Table 6). Not all subjects completed the Appetite questionnaires correctly as a result only 17 were factored in to the final results for long term appetite.

Thirst Response and Water Balance

AEx and REx both increased thirst following treatment, compared to CON, with no difference in response between AEx and REx (7.4 ± 2.6 vs. 6.2 ± 3.1 vs. 3.1 ± 2.5). Thirst remained higher until 45 minutes after exercise. The CON actually elicited a slight decrease in thirst from the start of the trial. Table 5 shows that the exercise trials elicited a greater change in thirst than the CON. The difference in the amount of water lost between each trial was significant (0.617 ± 0.241 vs. 0.181 ± 0.085 vs. 0.071 ± 0.026 kg H₂O lost). Significantly more water was lost through sweat during AEx. Ad libitum water intake immediately following the pasta salad meal was significantly different between both AEx, REx and CON (212 ± 41 mL, 218 ± 46 mL, 127 ± 25 mL).

DISCUSSION

The present study evaluated the effect of resistance and aerobic exercise on hunger and food intake. Resistance exercise has never been studied in this way and was hypothesized to increase hunger and food intake. Our findings for aerobic exercise were in contrast to the findings of previous studies. While many other studies have found a decreased food intake compared to rest with aerobic exercise our study found an increase (3, 12, 17). This increase however was not enough to compensate for the amount of energy expended through exercise and as a result the REI was lower for AEx than the CON. REx produced the results that restate what these were with an increase in pasta intake compared to the CON but not compared to AEx. However REx was significantly higher than either the CON or AEx. Our findings of increased food intake but decreased REI from AEx compared to CON are consistent with several other studies (1, 5, 11). A possible explanation for the current findings may be that the subjects of the present study were younger and more fit than many other studies which may explain some of the higher levels of compensation seen in our results.

The idea of the anorexia of exercise also includes decreased feelings of hunger following aerobic exercise (1). Hunger was evaluated and it was hypothesized that REx would increase feelings of hunger relative to CON or AEx immediately following exercise. REx did increase hunger immediately after exercise compared to AEx but 30 minutes post-exercise the hunger ratings for AEx, REx and CON were not statistically different. Immediately following exercise hunger was suppressed for AEx which is consistent with many other studies and the anorexia of exercise (3, 4). Some have indicated that this effect disappears somewhere between 30-60 minutes after exercise but the return of hunger seems to follow just before the meal is served which is what was found in the current study (3). This study found almost a complete

disappearance of this effect 30 minutes after exercise which corresponded with the serving of the test meal (Figure 2). This may be because the subjects were anticipating being served the meal. Our results indicate that there is no anorexia of exercise associated with resistance exercise but further studies are needed to support this.

Thirst was also evaluated to determine if there may be any correlation with thirst, water loss and food intake. AEx stimulated the greatest total water loss during the exercise treatment which stimulated the greatest thirst response following all treatments. The thirst ratings converged and were not significantly different during the meal despite the subjects still having a water deficit during the AEx. The amount of water given was fixed which meant that during REx and CON more water was consumed during and after exercise than was lost while in AEx more water was lost than water consumed. The ad libitum water intake following the meal was significantly different between the treatments. AEx and REx were higher than CON despite minimal sweat losses from REx when compared to AEx. These findings are supported by a study by McKiernan and colleagues suggest that hunger, thirst and food intake are loosely connected (18). They also find that thirst ratings seem to be a better predictor of water intake than hunger ratings are of food intake. Our results support the idea that thirst and negative or positive water balance do not appear to have a significant influence on food intake following either aerobic or resistance exercise.

Description of Strengths and Weaknesses

The present study is the first to evaluate resistance exercise's effects on hunger and food intake. The REx treatment was designed to be similar to a typical resistance exercise workout. It may have also been beneficial to offer more than just one study food (pasta salad) however this

was the most practical way to deliver a well balanced post exercise food to the subjects that was homogenous and easily measured. It would have also been interesting to assess the role of the timing of the food consumption during the course of the day.

Conclusion

This study was the first to assess the effect of resistance exercise on hunger and food intake compared with aerobic exercise. Our findings indicate that while there is a brief suppression of hunger with aerobic exercise there does not appear to be one with resistance exercise. The acute food intake after aerobic and resistance exercise was not significantly different but both were greater than the control. The REI of AEx was lower than CON or REx. In conclusion, there does not appear to be an anorexia of exercise for resistance exercise and that food intake is increased relatively more than with aerobic exercise.

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TABLES AND FIGURES

Table 1. Subject Characteristics

	Subjects (n=19)
VO ₂ Max (mL•kg ⁻¹ •min ⁻¹)	55.9 ± 3.0*
Age (y)	22 ± 1
Height (cm)	172.8 ± 1.8
Weight (kg)	67.3 ± 1.7
BMI (kg•m ⁻²)	22.5 ± 0.4
Body Fat (%)	18.6 ± 1.9
Fat Mass (kg)	13.4 ± 1.5
Lean Body Mass (kg)	55.0 ± 2.2
Seated Row 1 RM (kg)	30 ± 2
Leg Extension 1 RM (kg)	37 ± 2
Chest Press 1 RM (kg)	27 ± 2
Leg Curl 1 RM (kg)	31 ± 2
Leg Press 1 RM (kg)	111 ± 7
Upper Body 1RM Sum (kg)	57 ± 5
Lower Body 1RM Sum (kg)	179 ± 10

*N=18

¹All subjects met study inclusion criteria. Data expressed as mean ± SEM.

Table 2. Pasta Salad Macronutrient Composition

Property	Pasta Salad
Weight (g)	1219.79
Energy Density (kcal/g)	1.52
Energy (kcal)	1858
Carbohydrate (g)	271
Fiber (g)	0
Fat (g)	58
Protein (g)	71

*Pasta Salad Ingredients: Barilla Tri-Color Rotini, Kraft Light Done Right Italian Salad Dressing, and Kraft Shredded Parmesan Cheese

Table 3. Resistance Exercise Weight Lifted

Exercise	Weight (kg)	% 1 RM	Repetitions
Upper Back (Seated Row)	21.6 ± 1.7	70%	29 ± 1
Leg Extension	26.9 ± 1.8	70%	29 ± 1
Chest Press	19.2 ± 1.8	70%	30 ± 1
Leg Curl	21.6 ± 1.3	70%	30 ± 0
Leg Press	81.7 ± 5.6	70%	31 ± 0
Total	171.0 ± 11.4	70%	150 ± 2

¹All subjects were able to successfully complete the REx trials at the prescribed 70% of 1 RM.

Table 4 Two-Day Food Intake

	Control	Aerobic	Resistance
Energy Intake (kcal)	3883 ± 266	4030 ± 279	4239 ± 315
Protein (%kcal)	16.4 ± 0.8	16.1 ± 0.7	16.4 ± 0.6
Fat (%kcal)	30.9 ± 1.2	30.4 ± 1.2	32.1 ± 1.2
Carbohydrate (%kcal)	55.4 ± 1.4	56.1 ± 1.4	53.7 ± 1.4

¹Two-Day food intake was not significantly different in any way between treatments.

Table 5. Acute Changes in Hunger and Thirst

Trial	Change in hunger pre exercise to post	Change in Hunger Post exercise to pre-meal	Change Thirst pre exercise and post exercise	Change in Thirst Pre Meal to Post Meal
Control	1.24 ± 0.48	2.12 ± 0.28	1.18 ± 0.45	1.32 ± 0.62
Aerobic	-1.68 ± 0.63	4.29 ± 0.70	-2.26 ± 0.53	-0.15 ± 0.61
Resistance	1.03 ± 0.52	2.62 ± 0.38	-0.82 ± 0.77	-0.18 ± 0.38

¹Hunger was decreased following AEx compared to REx and CON. Hunger levels were not significantly different immediately before the meal. (p<0.05)

²Thirst was significantly greater immediately following AEx and REx compared to CON. Thirst was not significantly different between the treatments immediately before the meal. (p<0.05)

Table 6. Total Hunger, Fullness and Thirst Area Under the Curve (AUC)

Trial	Hunger Mean	Fullness Mean	Thirst Mean
Aerobic	-21.48 ± 25.69	113.94 ± 17.03	-.99 ± 22.23
Resistance	-36.32 ± 23.21	91.96 ± 16.54	-75.27 ± 22.44
Control	-56.40 ± 24.65	84.93 ± 21.66	-52.35 ± 24.08

There was no effect on overall Hunger, Fullness and Thirst using the AUC.

Figure 1. Testing Session Time Line

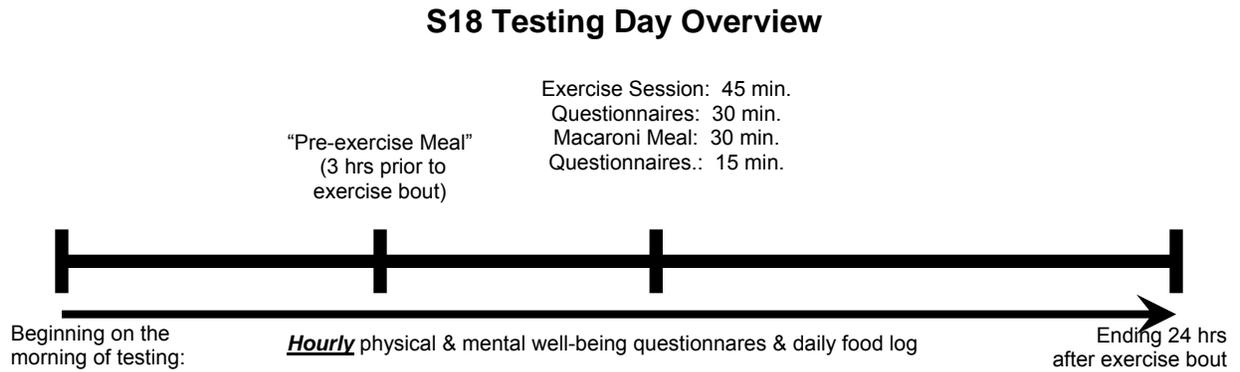
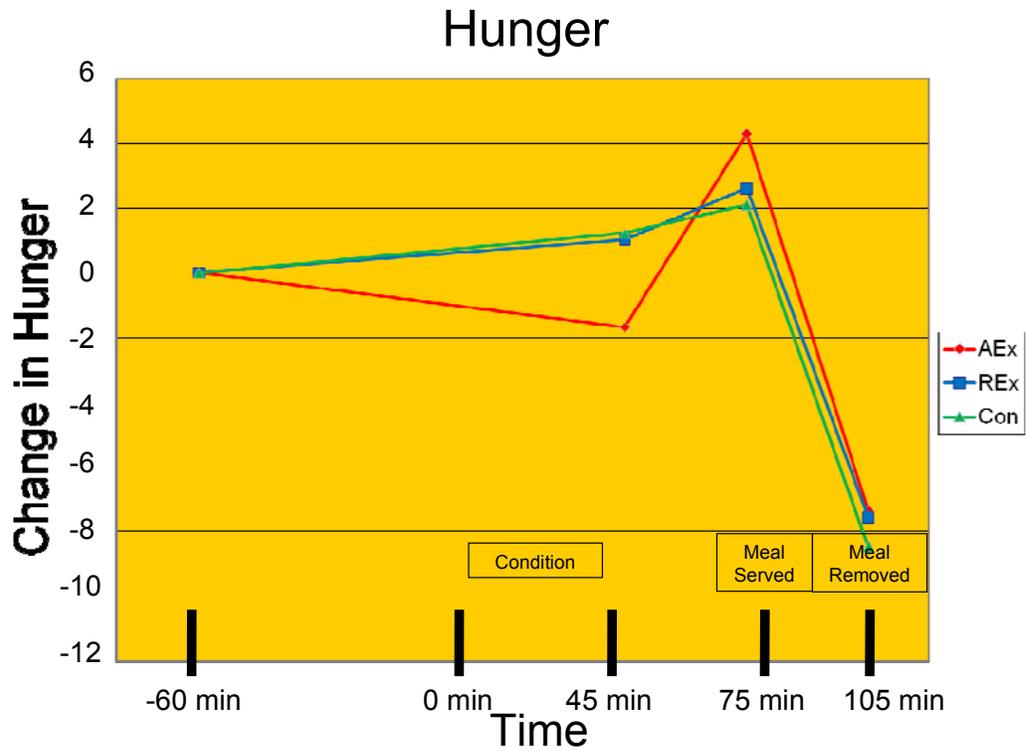
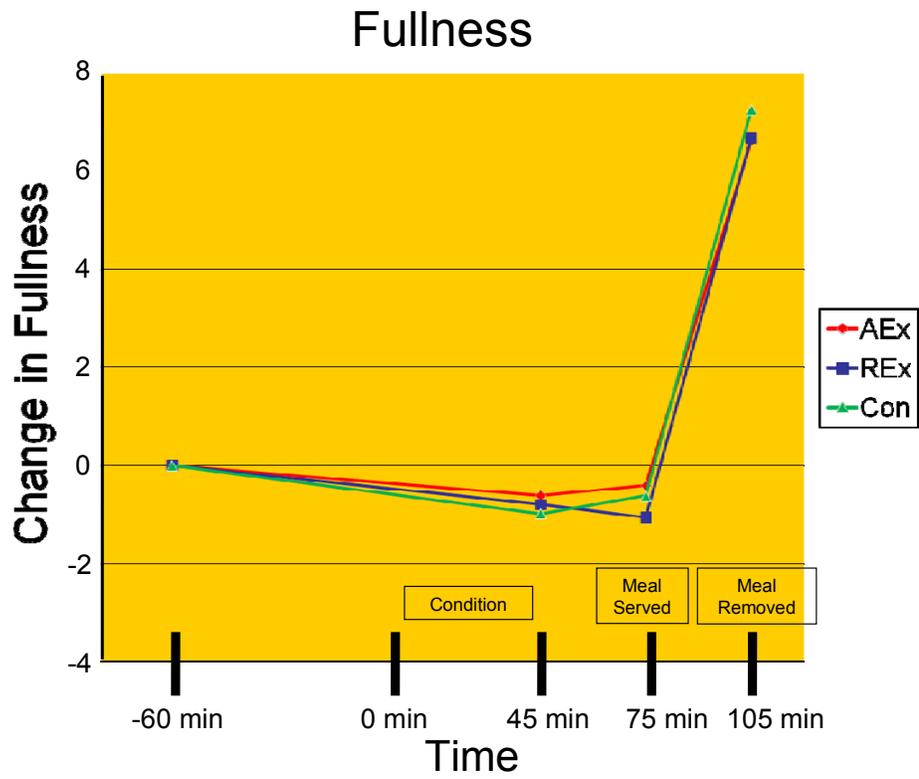


Figure 2. Change in Hunger



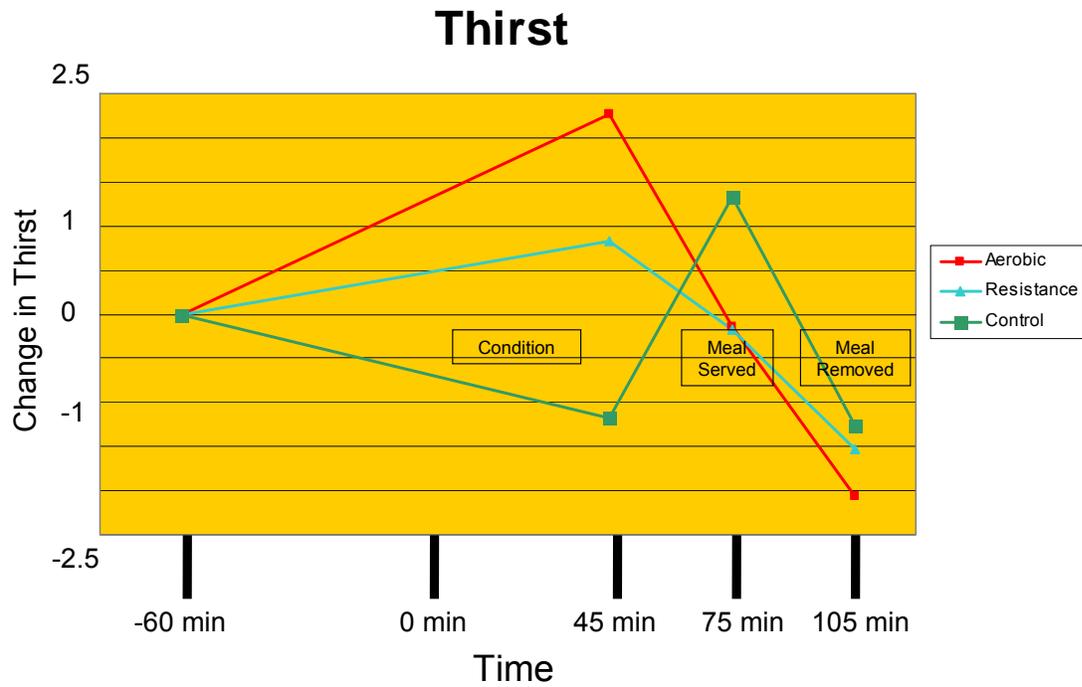
¹Hunger was decreased immediately following AEx. Hunger was increased slightly by REx and CON. Immediately before the meal hunger levels were the same for all treatments. ($p < 0.05$)

Figure 3. Change in Fullness



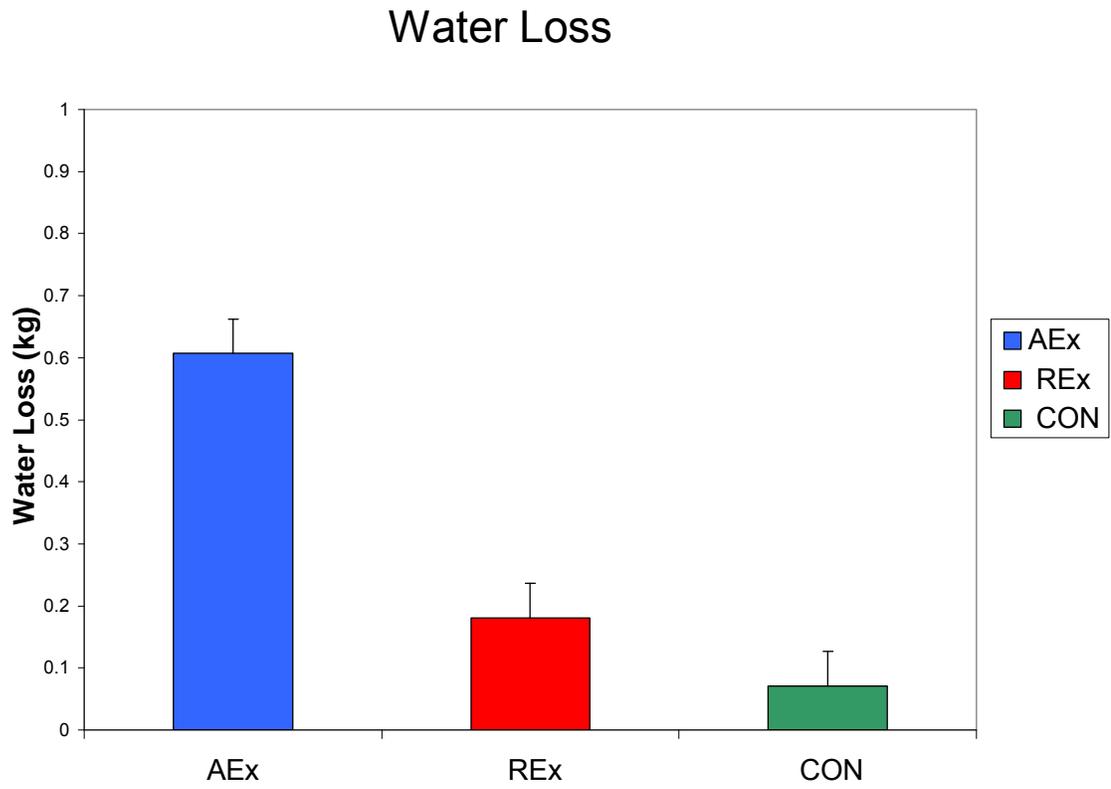
¹Fullness decreased for all treatments and was not significantly different at any time point between the treatments. ($p < 0.05$)

Figure 4. Change in Thirst



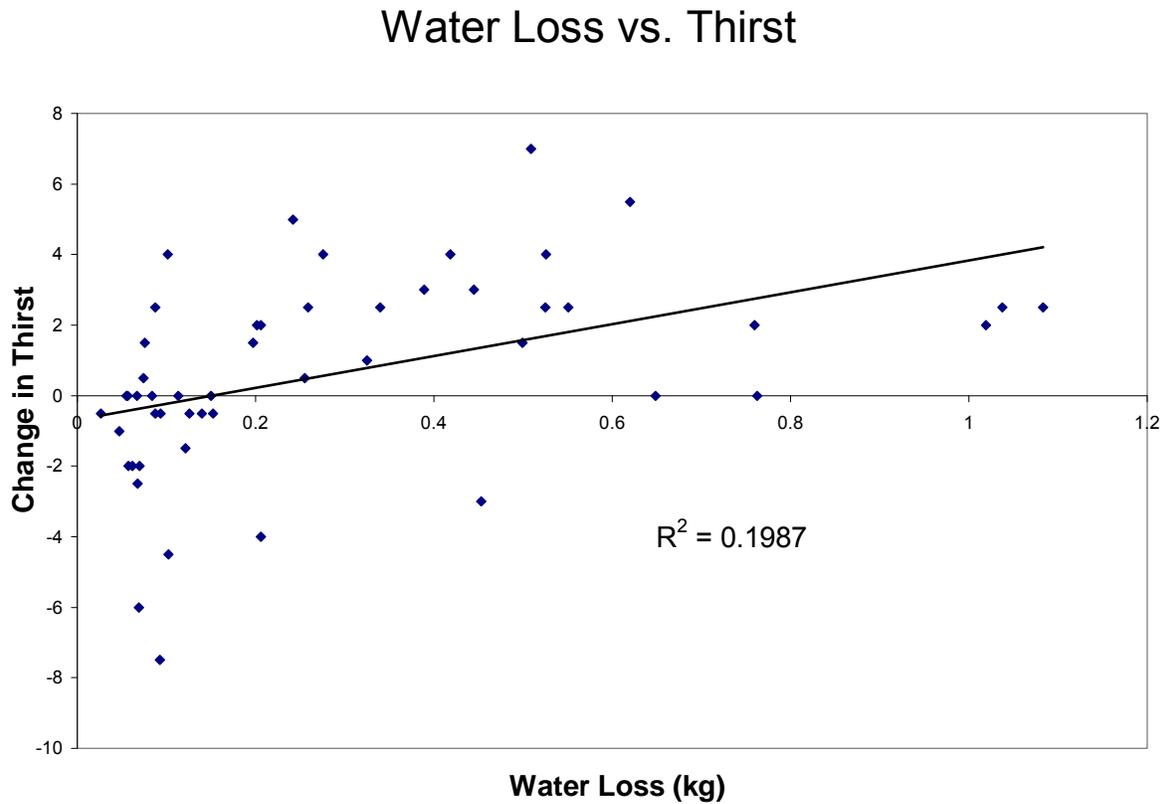
¹Thirst increased most after AEx but was also increased after REx. Thirst decreased following CON but was increased before the meal. ($p < 0.05$)

Figure 5. Water Loss



¹ The difference in water loss between all treatments is significant. ($p < 0.05$)

Figure 6. Water Loss vs. Thirst



¹ The association of water loss and change in thirst from pre to post treatment. With increased water losses there was an increase in thirst pre to post exercise.

APPENDICES

APPENDIX 1

YMCA Submax Protocol

Submax: YMCA Cycle Ergometry Protocol

ID: _____

Date: _____

Age: ____yrs

Predicted HR Max (220-age): _____

85% HR Max (Predicted HR*0.85): _____

Stage	Time (min)	Work Rate (kg)	RPM	Heart Rate (bpm)	RPE
Baseline	0	N/A	N/A		
1	1	0.5	50	---	---
1	2	0.5	50		---
1	3	0.5	50		
1	4	0.5	50		
2	4 5		50	---	---
2	5 6		50		---
2	6 7		50		
2	7 8		50		
3	7 8 9		50	---	---
3	8 9 10		50		---
3	9 10 11		50		
3	10 11 12		50		
4	10 11 12 13		50	---	---
4	11 12 13 14		50		---
4	12 13 14 15		50		
4	13 14 15 16		50		

*Highlighted cells are only used if the HR is inconsistent (> 5 bpm) from the 2nd to the 3rd minute within stages; thus, the 4th minute is required.

APPENDIX 2

Informed Consent Form

RESEARCH PARTICIPANT CONSENT FORM-STUDY
The Body's Response to Aerobic vs. Resistance Exercise

Wayne W. Campbell, Ph.D.
Purdue University
Department of Foods and Nutrition

PURPOSE OF RESEARCH

The purpose of this study is to identify the body's response to aerobic vs. resistance exercise. Throughout this study, we will examine your food intake, appetite, and physical and mental well-being before, during, and after aerobic and resistance exercise.

Procedures to be Used

1.) *Baseline Measurements: (Week 1)*

OF DAYS: 2; 1 ½ hrs/day; TOTAL ESTIMATED TIME: 3 HRS

Upon meeting the study screening criteria, I will read and complete this Participant Consent Form. On 2 separate days, I will report to the Ismail Health, Exercise, and Nutrition Center or to the laboratory in Stone Hall to complete the baseline measurements. During visit 1, I will be instructed on the proper use of the resistive equipment and the bike during an acclimation session. My aerobic fitness level will then be assessed. During visit 2, I will perform my maximal strength assessment. During week 1, I will also complete the Three-factor Eating questionnaire and the Block Food-frequency questionnaire. I will complete 3 daily food records, 3 meal-frequency logs, and 3 days of hourly physical and mental well-being questionnaires assessing daily caloric intake, meal-timing, appetite feelings, and general well-being. During the same 3 days, I will also be asked to wear an activity monitor that measures my daily physical activity.

Specific Baseline Measurements:

Strength and Aerobic Fitness Assessments

After I have been instructed on the proper use of the resistive exercise equipment and the bike, my aerobic fitness level will be assessed.

During the aerobic fitness test, I will be asked to ride a bike at various resistances and speeds until I reach 2 similar heart rates that fall within the range of 110 heart beats per minute or 85% of my estimated maximal effort (i.e., 85% of my age-predicted maximal heart rate). My heart rate will be continuously monitored using a heart-rate monitor.

My maximal strength assessment will be determined by measuring the most amount of weight that I can lift for specific exercises (i.e., seated row, double leg press, seated leg curl, chest press, and leg extension).

Dietary Intake, Meal-Frequency, and Physical and Mental Well-being

I will write down all the foods and beverages I eat and drink during three separate days. I will be given instructions on how to make the food lists accurately. I will also complete a meal-frequency questionnaire assessing the number and times of meals. I will also complete hourly physical and mental-well being questionnaires on three separate days. I will be given instructions on how to complete these questionnaires as well.

Physical Activity

During the same three days as listed above, I will wear an activity monitor (Caltrac) that measures my physical activity each day. This device is worn on my hip and looks like a “pager.”

2.) Testing Sessions (Weeks 2-6)

OF DAYS: 12; 2 hrs/day; TOTAL ESTIMATED TIME: 24 HRS

I will complete 6 separate testing days. On the morning of each testing day, I will complete hourly physical and mental well-being questionnaires and a daily food log until I arrive at the exercise facility in Ismail Health, Exercise, and Nutrition Center. I will then complete a daily pre-exercise questionnaire addressing “exercise readiness” and changes in health and will randomly complete 1 of 3 testing sessions:

1.) Resistance Exercise

I will individually perform 3 sets of 8-10 repetitions at 70% of my pre-determined maximal strength for the following exercises: Seated Row, Leg Press, Seated Leg Curl, Chest Press, and Leg Extension. I will perform each repetition in a slow (6 to 8 seconds) uniform fashion, giving equal time

to the concentric (muscle shortening) and eccentric (muscle lengthening) portions. One minute of rest will be allowed between sets. The last repetition of the third set of each exercise will be done to voluntary fatigue or the performance of 12 repetitions. This session will be approximately 45 minutes in duration.

2.) Aerobic Exercise

I will individually perform 45 minutes of aerobic exercise on a stationary bike at an exercise intensity of 70% of my heart-rate reserve, which is defined as my maximal heart rate – resting heart rate.

3.) Control-no exercise

I will perform various tasks that measure hand steadiness, alertness, and mental acuity over a 45 minute period.

I will have my body weight measured on a digital scale before and immediately following each testing session. I will also collect a urine sample of approximately 2-3 oz. before and immediately following each testing session.

I will have an adequate warm-up and cool-down following both the resistance and aerobic exercise sessions. I will perform EACH of the 3 testing sessions on separate days. I will also perform EACH of the 3 testing sessions twice to where I complete 6 days of testing. I will be provided with 8 oz. of water to consume throughout the 45 minute period for each testing day.

Following each testing session, I will complete the physical and mental well-being questionnaires every 15 minutes for 60 minutes. Thirty-minutes after the testing session, I will consume a macaroni casserole meal until I have reached a “comfortable level of fullness.” I will also be provided with 8 oz. of water to consume during my meal. Fifteen minutes after finishing my meal, I will be provided with bottles of drinking water and will be allowed to consume as much water as I choose. At the end of the 60-minute period, I will be permitted to leave the laboratory.

Until the end of the following day, I will complete the hourly physical and mental well-being questionnaires, a daily food log, and the meal-frequency questionnaire.

Duration of Participation

I will be asked to complete the entire study lasting over a 5-6 week period. I will complete the baseline testing, which includes 2 days of testing lasting approximately 1 ½ hrs per day. I will then complete 6 testing days lasting 2 hrs each day. My study involvement will be approximately 24 hrs. I will have 2-7 days in between similar testing days and 5-14 days in between different testing days.

Benefits to the Individual

I understand that no benefit is guaranteed to me from participating. I may feel that being involved in research in a university setting is a personal benefit. However, the knowledge gained from this study should benefit society by providing insights on how the body responds to resistance and aerobic exercise. The information obtained from this study may aid in designing exercise interventions to hopefully slow the increasing prevalence of abnormal weight regulation (i.e., obesity) in both younger and older people.

Risks to the Individual

I understand that some risk may be associated with the resistive exercise and aerobic fitness testing. However, if I follow the proper warm-up and cool-down procedures these risks will be minimal but may include muscle tightness, soreness and fatigue, pulled muscles, and rarely joint and bone injury. The cardiovascular risks of performing these exercises and tests are very low but include, rarely, cardiac arrhythmia requiring immediate treatment, angina pectoris, myocardial ischemia, and death. The risks associated with the resistive exercise testing and training will be minimized as the exercise procedures will be thoroughly explained and demonstrated to me for proper use of the exercise equipment.

There are no known risks when having my body weight measured or collecting a urine sample.

There may be some risks of my stomach or bowels becoming upset due to any changes in my usual food and beverage intake.

Compensation

I will be paid \$200 for completing this study. If I choose to end my participation before the end of the study, I will receive \$25 for each testing session completed. I understand that my name, social security number and address will be provided to the business office of Purdue University for the purpose of facilitating payment to me for participating in this study.

Injury or Illness

I understand that Purdue University will not provide medical treatment or financial compensation if I am injured or become ill as a result of participating in this research project. This does not waive any of my legal rights nor release any claim I might have based on negligence.

Confidentiality

All data will be kept in a confidential file in a filing cabinet in a locked room for at least three years after the close of the study. To further insure confidentiality, computer records will never include my name. In the event of any publication resulting from the research, no personally identifiable information will be disclosed. This information will be available to the principal investigator or his designee for analysis purposes. The National Institutes of Health (NIH) may also review the research records. I understand that all data will be destroyed if/when I decide not to participate in the study. This includes the data obtained during the screening and study periods. I understand that I have the option to allow or disallow the use of any of my data collected as a result of this research to be used for research that is unrelated to this study. I understand that if I do allow my data and/or specimens to be used for unrelated future research that none of it will be personally identifiable. My name and/or any related numbers will be removed. All data will be kept confidential, with the possible exception of review by the Purdue University Committee on the Use of Human Research Subjects.

Voluntary Nature of Participation

I do not have to participate in this research project. If I agree to participate I can withdraw my participation at any time without penalty.

Human Subject Statement:

If I have any questions about this research project, I can contact Professor Wayne W. Campbell at (765)494-8236. If I have concerns about the treatment of research participants, I can contact the Committee on the Use of Human Research Subjects at Purdue University, 610 Purdue Mall, Hovde

Hall Room 307, West Lafayette, IN 47907-2040. The phone number for the Committee's secretary is (765) 494-5942. The email address is irb@purdue.edu.

I HAVE HAD THE OPPORTUNITY TO READ THIS CONSENT FORM, ASK QUESTIONS ABOUT THE RESEARCH PROJECT AND AM PREPARED TO PARTICIPATE IN THIS PROJECT.

Participant's Signature

Date

Participant's Name

Researcher's Signature

Date

Please check only one of the two boxes below

I agree to allow the use of my data and/or specimens collected during this study to be used for future research that is unrelated to this study.

Participant's Signature

Date

I request my data and/or specimens collected during this study to NOT be used for any future research that is unrelated to this study.

Participant's Signature

Date

APPENDIX 3

Appetite Questionnaire

Physical & Mental Well-being Questionnaire

Subject ID _____ Date _____ Time _____

Please circle one mark “|---(1)---|” on each scale that best reflects your answer to each of the following questions at this time.

1. How strong is your feeling of hunger?

|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 1. _____
Not at all Extremely

2. How strong is your feeling of fullness?

|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 2. _____
Not at all Extremely

3. How strong is your desire to eat?

|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 3. _____
Not at all Extremely

4. How strong is your “urge to eat”?

|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 4. _____
Not at all Extremely

5. How strong is your preoccupation with the thoughts of food?

|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----| 5. _____
Not at all Extremely

13. Are you nauseated or "feel sick in your stomach"?

|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
Not at all 13. _____
Extremely

14. How much food do you think you can eat right now"?

|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
None 14. _____
Large Amount

Resume
Derek Laan
dlaan@purdue.edu
Cell Phone: (317)-965-0824

Address:

416 West Stadium Avenue
West Lafayette, IN 47906

EDUCATION

Purdue University, West Lafayette, IN

Bachelor of Science in Dietetics and Nutrition, Fitness, and Health, May 2009

GPA 3.61/4.0 Anticipate graduating with Honors

EMPLOYMENT

Undergraduate Research Assistant May 2008-Present

West Lafayette, IN

- Recruit subjects and run clinical research trials primarily relating to exercise and food intake
- Enter and analyzing data
- Prepare my research for submission to an academic journal

Undergraduate Tutoring Assistant, January 2007-Present

Purdue University Writing Lab, West Lafayette, IN

- Provide 30 minute one on one tutoring sessions for students in Freshman English at Purdue
- Lead English as a Second Language (ESL) conversation groups

Program Staff, June 2006- August 2006

YMCA Camp du Nord, Ely, MN

- Led families and groups of all ages in a variety of camp activities
- Supervised activities include sailing, hiking, canoeing outdoor games, team building, sing a longs, skits,
- Led families on one night camping trips which involved planning meals and outdoor cooking

VOLUNTEER WORK

Wilderness Camp Instructor June 2007-August 2007

Meari Camp, Seoul, South Korea

- Planned and lead week long back packing trips for Korean youth age 11-14 with Korean counselors
- Planned hiking routes, menu and food supplies for trips, and equipment selection
- Trained South Korean counselors about backpacking and outdoor camping skills such as cooking and n

HONOR'S AND AFFILIATIONS

- Purdue Cycling Club, President (Fall 2006), Race Organizer (Spring 2006-Present)
- Dean's Merit Scholarship Fall 2005-Spring 2009
- Dean's List Fall 2005, Spring 2006, Fall 2007, Spring 2008, Fall 2008
- Semester Honors Fall 2005, Spring 2006, Fall 2007, Spring 2008, Fall 2008
- Purdue Writing Lab Tutor of the Semester (Spring 2008)

SKILLS

- ServSafe Certification October 2004, through the National Restaurant Association
- Proficient in Microsoft Word, Excel, and Nutritionist Pro