GLYCEMIC RESPONSE TO RECOVERY MEAL DIFFERS FOLLOWING CONCENTRIC AND ECCENTRIC EXERCISE BOUTS

SARA E JAY, KAREN M BROWN, LAURA C HORRIGAN, ANDREA N STEWARD, JAY W PORTER, MARY P MILES, FACSM
MONTANA STATE UNIVERSITY, BOZEMAN, MONTANA

ABSTRACT

Exercise-induced muscle damage causes temporary insulin resistance, suggesting that recommended carbohydrate recovery foods may not be advantageous in some circumstances. Higher carbohydrate consumption after exercise may promote inflammation and decreased insulin sensitivity in individuals at greater risk for metabolic diseases. PURPOSE: To determine post-exercise recovery meal influence on insulin and glucose response in women with lower (<80 cm) and higher (>80 cm) waist circumferences. METHODS: Women (n=23, 21-36 years of age, BMI 19.8-33.8 kg/m^2, body fat 18.1-47.3%, waist circumference 66.9-101.6 cm) participated in a randomized cross-over study and completed 45 minute conditions including eccentric walking, concentric walking, and a no exercise control. Following exercise a controlled post-exercise mixed meal tolerance test (MMTT) consisting of 76% carbohydrate, 18% protein, and 6% fat was consumed. The MMTT was performed 30 minutes post exercise with glucose measured at 0, 15, 30, 60, 45, 90, 120 minutes, and insulin measured at 0 and 60 minutes. A repeated measured ANOVA was used to compare glucose 30 minutes post exercise before, peak glucose during, and area under the curve for glycemic response to MMTT, and insulin response 60 minutes post MMTT. RESULTS: Blood glucose area under the curve was lower (p<0.05) for concentric exercise in both waist circumference groups (<80cm Mean ± SEM; 12,554.42 min·mg/dL ± 266.8 min·mg/dL; >80cm Mean ± SEM; 12,737.5 min·mg/dL ± 304.2 min·mg/dL) compared to eccentric exercise (<80cm Mean ± SEM; 12,928.3 min·mg/dL ± 343.1 min·mg/dL; >80cm Mean ± SEM; 13,501.5 min·mg/dL ± 391.3 min·mg/dL) conditions. There was a trend (p=0.087) for glucose to be lower before the MMTT in the concentric (87.0 mg/dL ± 2.5 mg/dL) compared to eccentric (95.4 mg/dL ± 1.7 mg/dL) exercise. The peak glucose during the MMTT was significantly lower during the concentric in both waist groups (<80cm Mean ± SEM; 129.2 mg/dL ± 3.2 mg/dL; >80cm Mean ± SEM; 128.1 mg/dL ± 3.7 mg/dL) compared to eccentric (<80cm Mean ± SEM; 138.6 mg/dL ± 3.7 mg/dL; >80cm Mean ± SEM; 143.8 mg/dL ± 4.2 mg/dL) exercise conditions (p<0.05). There was a significant difference in insulin levels measured 60 minutes after consumption of the meal between no exercise (22.9 µIU/mL ± 5.2 µIU/mL) and eccentric exercise (31.3 µIU/mL ± 3.8 µIU/mL) for the <80cm waist circumference group (p<0.05). CONCLUSIONS: Blood glucose responses following a recommended post exercise recovery meal were similar between subjects, but were lower following concentric exercise compared to eccentric exercise. Insulin responses were lower in individuals with lower waist circumference after no exercise, increased levels after eccentric exercise.

INTRODUCTION

Regular exercise of 150 minutes per week is recommended for individuals to maintain a healthy lifestyle (1). Post exercise recovery meals are also recommended to obtain benefits from exercise (2). However, exercise-induced muscle damage causes temporary insulin resistance (3), suggesting that recommended carbohydrate recovery foods may not be advantageous in some circumstances or for some individuals (4). Higher carbohydrate consumption after exercise may promote inflammation and decreased insulin sensitivity in individuals at greater risk for metabolic diseases (5).

PURPOSE

The purpose of this study was to determine post-exercise recovery meal influence on insulin and glucose response in women with different body fat distributions resulting in lower (<80 cm) and higher (>80 cm) waist circumferences.

METHODS

Participants:

- 23 healthy females completed the study (Table 1)

	Group	
	<80cm (n=13)	>80cm (n=10)
Age (years)	26.38 ± 5.11	30.90 ± 5.49
Body mass (kg)	59.65 ± 6.81	83.47 ± 12.66
Height (cm)	164.72 ± 4.43	166.06 ± 5.56
BMI (kg/m^2)	22.10 ± 2.27	30.21 ± 3.60
Waist (cm)	71.48 ± 4.57	92.65 ± 8.98
Hip (cm)	90.52 ± 7.77	108.62 ± 13.62
WH	0.79 ± 0.04	0.86 ± 0.98
Body Fat %	24.84 ± 6.76	38.69 ± 8.59
Fat Mass (kg)	15.11 ± 5.08	32.92 ± 11.11
LBM (kg)	44.85 ± 4.50	50.48 ± 4.90
Glucose (mg/dL)	95.13 ± 7.74	98.45 ± 8.06
Est. VO_{2max} (ml/kg/min)	46.91 ± 7.74	98.45 ± 8.06

Table 1. Subject characteristics. Vales are mean ± SD, p<0.05

Baseline Measures:

- Anthropometric, body composition, resting BP and HR
- Sub-maximal modified Bruce treadmill test

Experimental Design:

- Randomized cross-over study
- Three 45 min exercise conditions
  - Concentric Exercise (10% grade, 2-3.5 km/hr, 60% VO_{2max})
  - Eccentric Exercise (-10% grade, 3.0 km/hr, +10% BW)
  - Control Exercise (sitting, serving as own control)
- MMTT was consumed 30 min post exercise (Table 2), CHO/PRO = 4

Food Item	Amount (g)	CHO (g)	PRO (g)	FAT (g)	Kcal
Graham Crackers	31	24	2	3	130
Chobani Nonfat Strawberry Yogurt	227	27	19	0	190
Raisins	30	23.25	0.75	0	97.5
Gatorade	8	14	0	0	50
Total		**88.25**	**21.75**	**3**	**467.5**
Total Kcals		353	87	27	467
Percentage of Kcals		75.6%	18.6%	5.8%	100.0%

Table 2. Post-Exercise Mixed Meal Tolerance Test

Analysis:

- Glucose was measured at 0, 15, 30, 60, 45, 90, 120 min post exercise
- Insulin was measured at 0 and 60 min post exercise
- Blood was collected through a finger stick at the time points of interest
- Multivariate repeated measures ANOVA analyses
  - Area under the curve (AUC), peak plasma glucose (PBG), fasting plasma glucose (FBG), and insulin

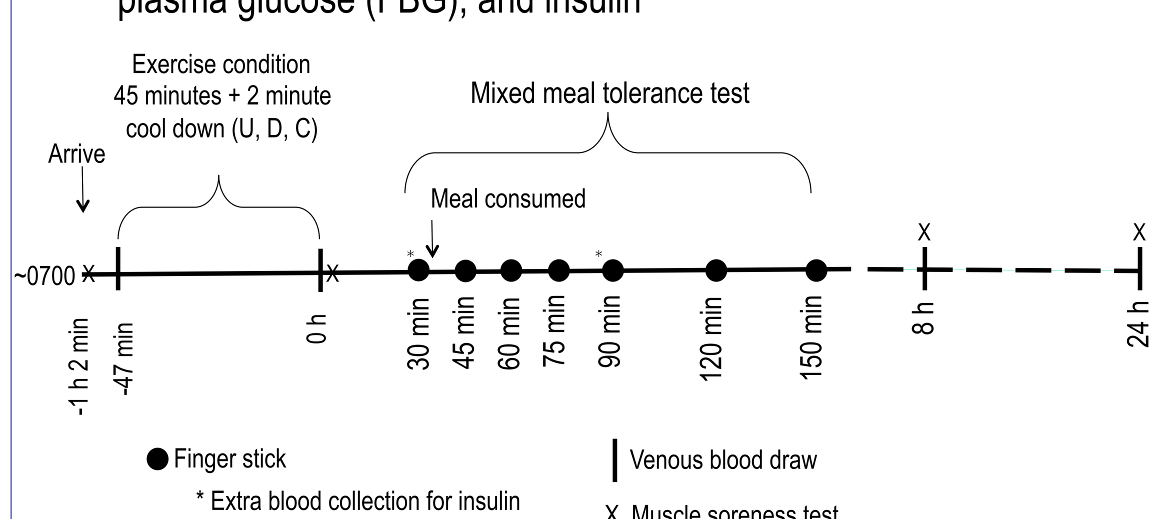

Figure 1. Timing of research protocol events within each condition. (U=uphill exercise, D=downhill exercise, C=control exercise).

RESULTS

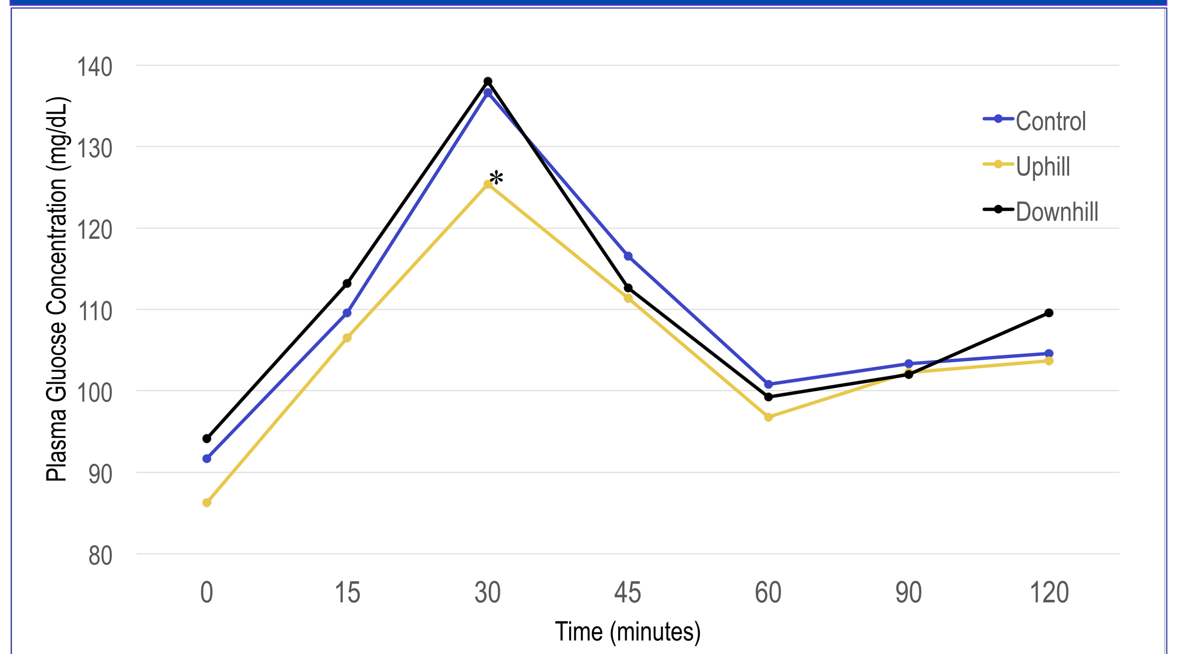

Figure 2. Plasma Glucose Response to Post-Exercise MMTT

- The plasma glucose MMTT response was significantly different between the uphill and downhill exercise conditions (p=0.018).
- Less glucose was needed following uphill exercise when compared to downhill exercise (Figure 2).
- AUC was significantly lower in the uphill exercise condition versus the downhill exercise (p=0.018) (Figure 3).

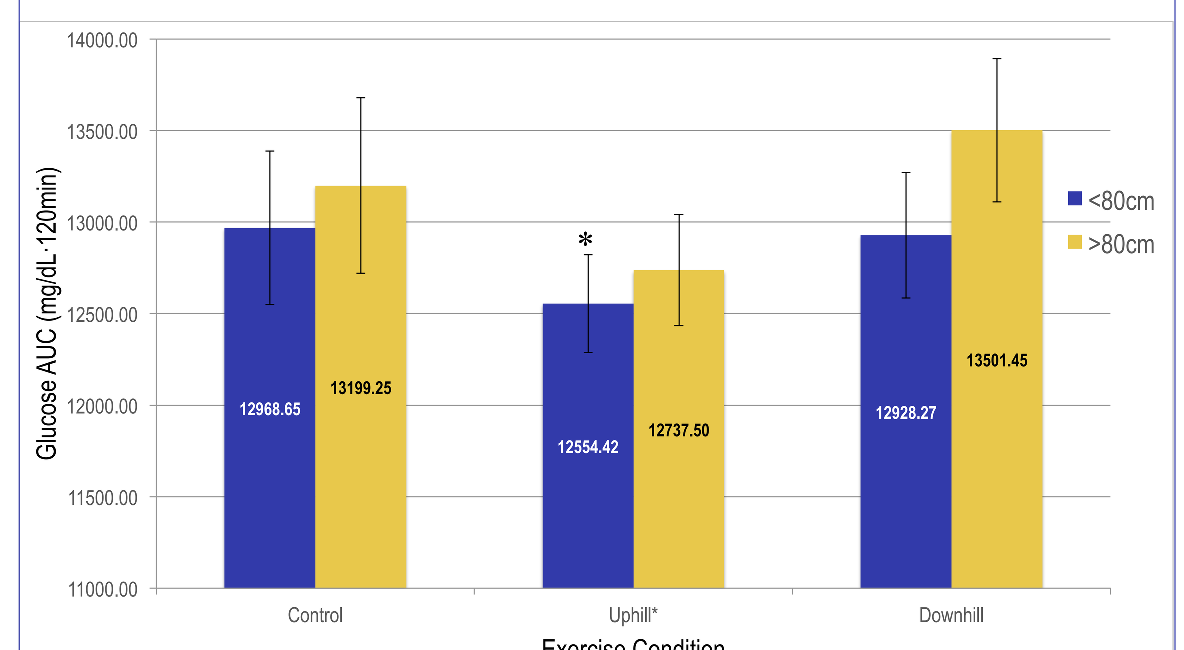

Figure 3. Glucose AUC After Post-Exercise MMTT Values = Mean ± SEM. *p<0.05.

- FBG was significantly different between the control and uphill exercise conditions (p=0.016), and between the uphill and downhill exercise conditions (p=0.001).
- FBG was lower in both <80cm (86.39 mg/dL) and >80cm (86.60 mg/dL) groups after uphill exercise.
- PBG was lowest after uphill exercise for both <80cm (129.15 mg/dL) and >80cm (128.10 mg/dL) groups (Figure 4).

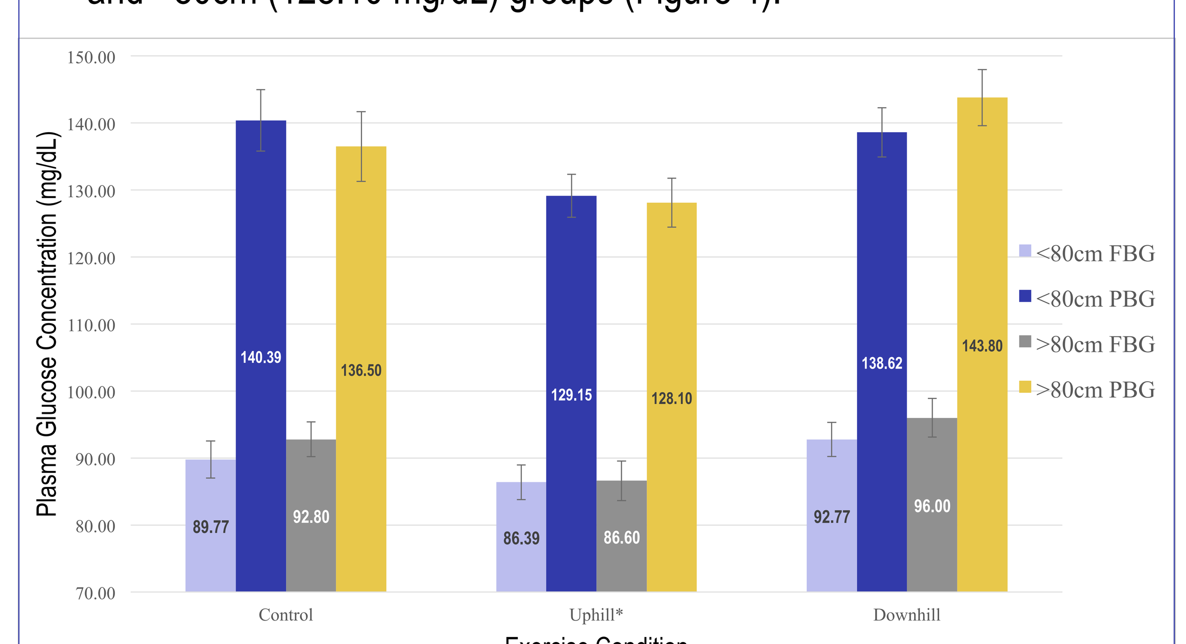

Figure 4. Fasting and Peak Glucose Response to MMTT Values = Mean ± SEM. *P<0.05.

RESULTS

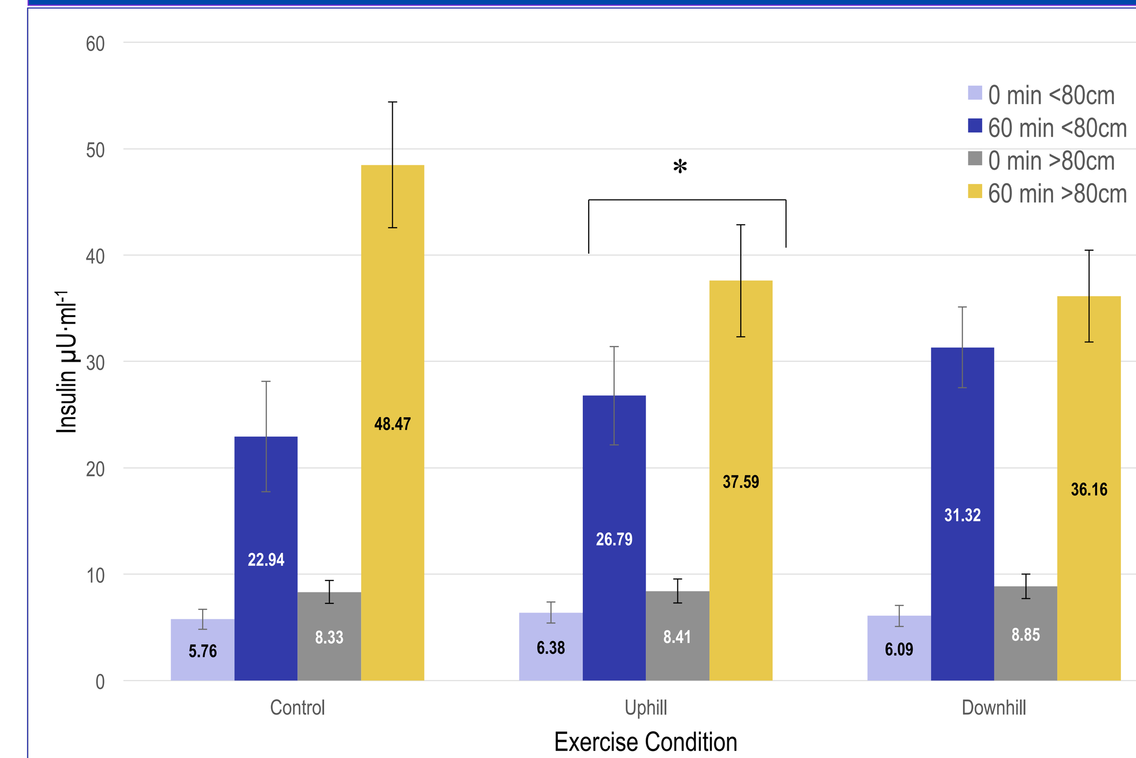

Figure 5. Insulin Response to MMTT. Values = Mean ± SEM. *P<0.05.

- There was a significant difference in insulin 60 minutes after the control exercise versus the downhill exercise in the <80cm (p=0.008), but not in the >80cm (p=0.120) groups.
- Without exercise more insulin was needed in response to the MMTT (Figure 5).

CONCLUSION

- Blood glucose responses following a recommended post exercise recovery meal (CHO/PRO = 4) was lower following concentric exercise compared to eccentric exercise in both waist circumference groups.
- A lower amount of insulin was needed after exercise for individuals with a lower waist circumference.
- More insulin was needed without exercise in individuals with greater waist circumference.
- Recovery meal recommendations depend on individual and the type of exercise performed.

REFERENCES

1. USHHS. Physical Activity Guidelines for Americans. 2008.
2. USDA. Dietary Guidelines for Americans. 2010
3. Miles MP. Metabolism. 2010;59:1456-1464.
4. Depner CM. Eur J Appl Physiol. 2010;109:1067-1076.
5. Miles MP. Am J Lifestyle Med. 2012;2:121-132. Sage Journals.

ACKNOWLEDGEMENTS

Research reported in this publication was supported by the National Institute of General Medical Sciences of the National Institutes of Health under Award Number P20GM103474. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.