

Carbohydrate & Protein Sports Beverages: Implications for Endurance Performance and Muscle Recovery

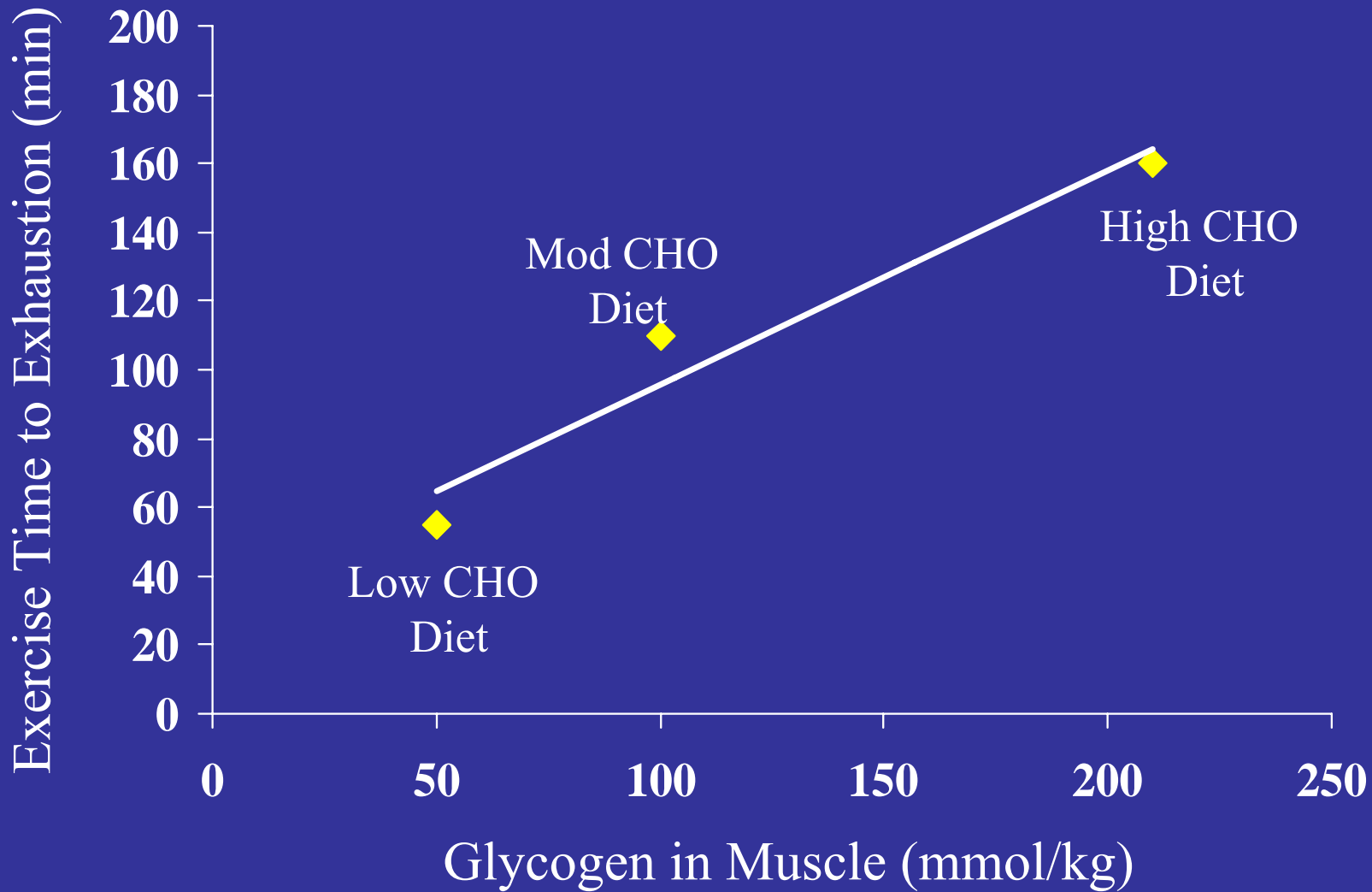
Mike Saunders, Ph.D.

Basic Issues of Sport Nutrition

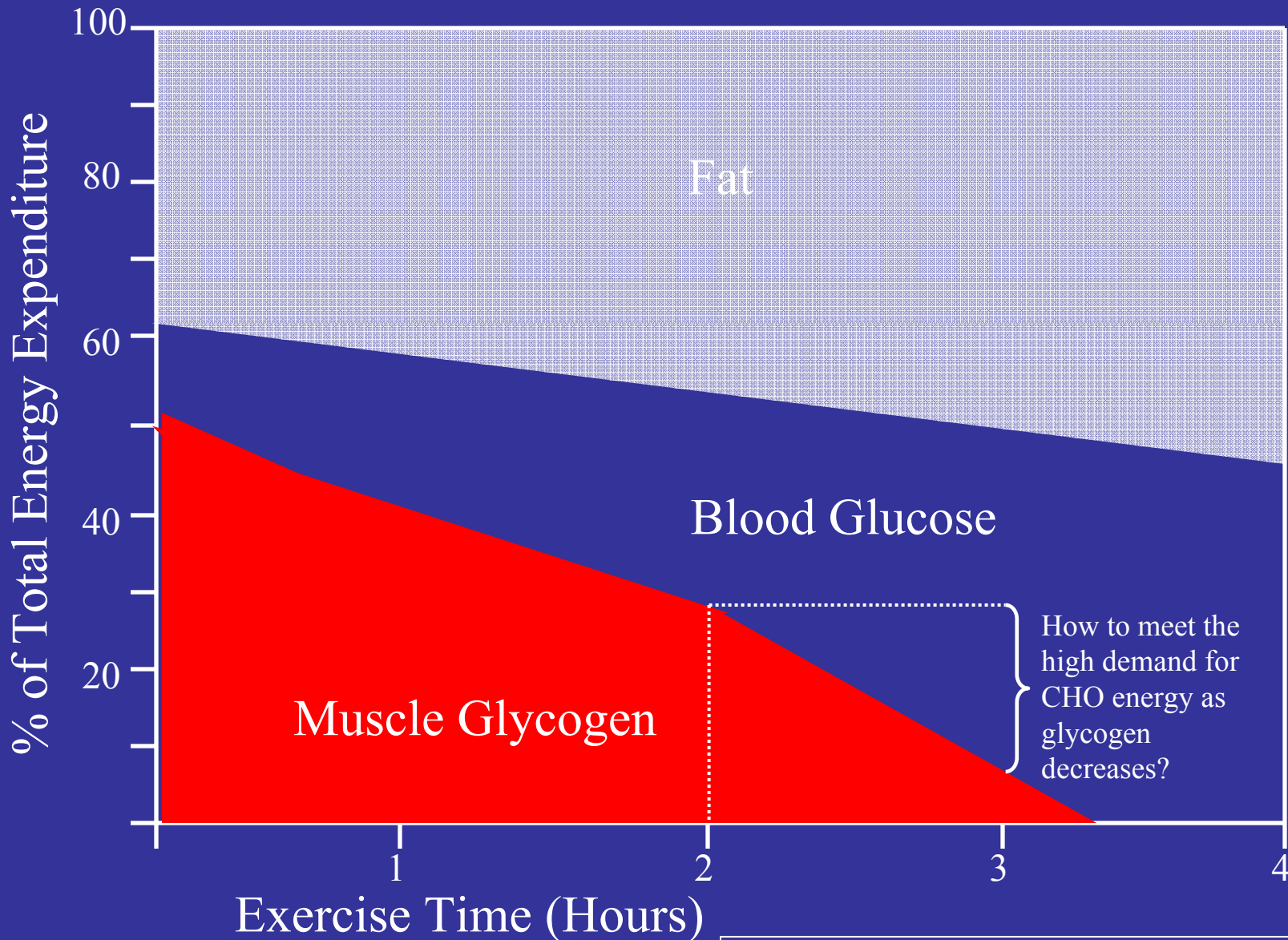
- Potential Influences of Sport Nutrition
 - Effects on Acute Performance
 - Effects on Muscle Recovery
 - Muscle damage
 - Muscle glycogen replenishment
 - Effects on Subsequent Performance
- Carbohydrate and/or Carbohydrate-Protein Intake
 - Is it important?
 - How does it help?
 - Importance of Nutrient Timing



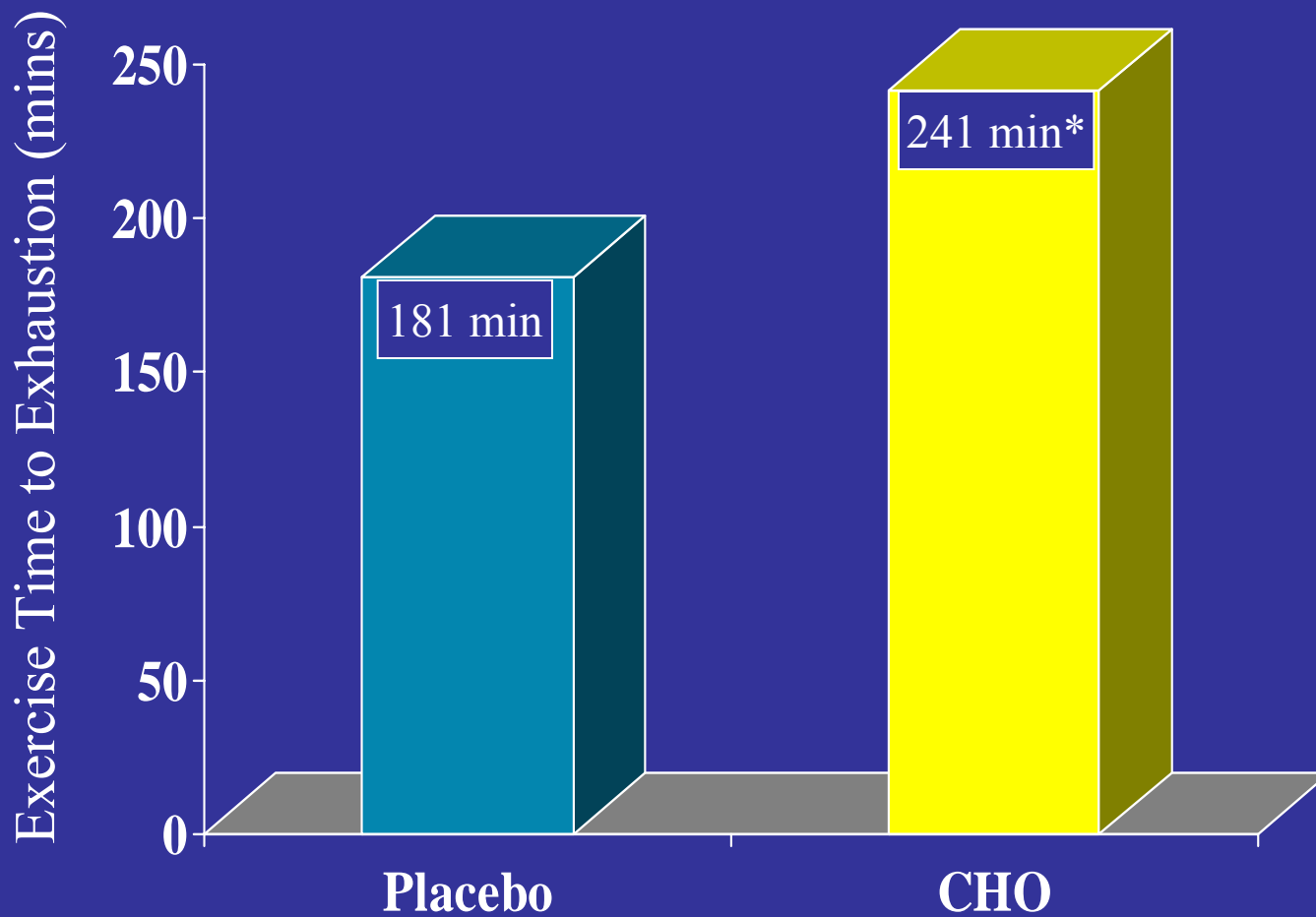
Importance of Dietary Carbohydrates



Importance of CHO During Exercise

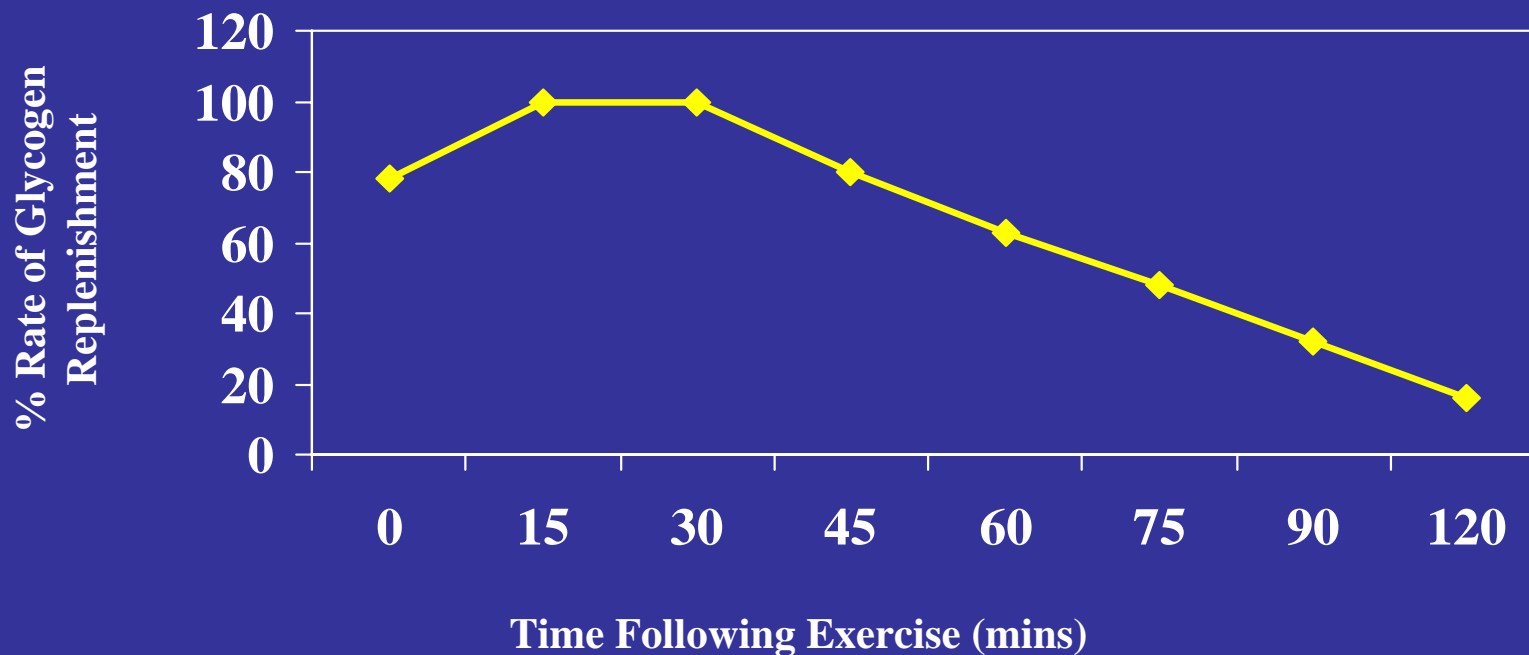


Carbohydrate Intake During Exercise



Carbohydrate & Muscle Recovery

- Normally, 24-48 hours needed after exercise to replenish glycogen stores
- Maximize your “glycogen replenishment window” by consuming carbohydrate immediately post-exercise





Carbohydrate/Protein Beverages

So, it is well established that we need carbohydrate:

- In the regular diet
- During prolonged endurance activities
- Immediately following exercise

In recent years, some nutritional products have claimed various benefits of adding protein to traditional carbohydrate-only sports drinks

- Improved performance
- Reduced muscle damage
- Improved muscle recovery

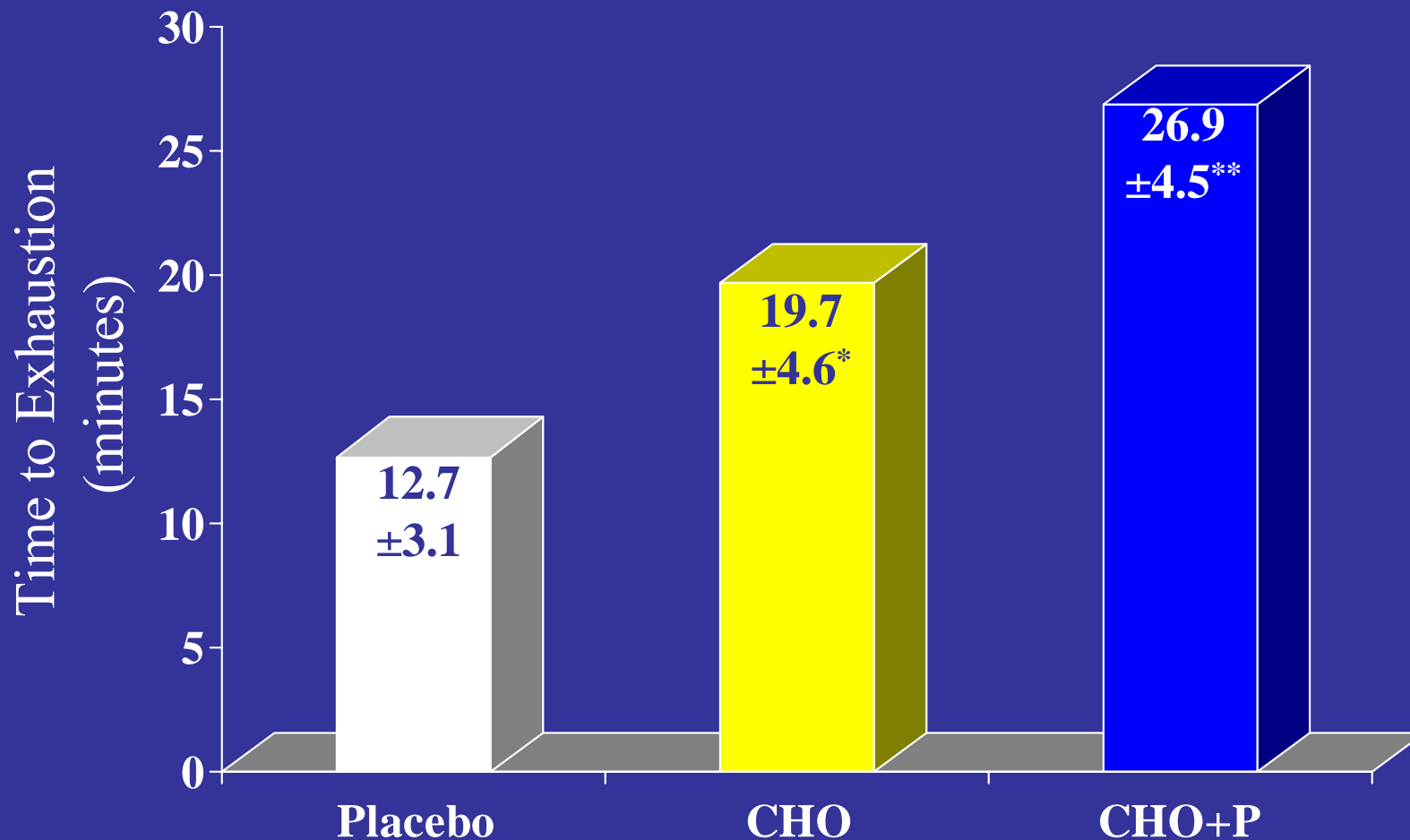
CHO+P Beverages: Effects on Endurance Performance

- Ivy et al., 2003
 - Cycling performance compared between placebo, CHO, and CHO+P beverages
 - Performance trial consisted of time to exhaustion at 85% VO_{2max} following 180 minutes of varied intensity cycling (45-75% VO_{2max})

Ivy et al., *Int J Sports Nutr Exerc Metab*, 13, 382-395, 2003.

CHO+P Beverages:

Effects on Endurance Performance

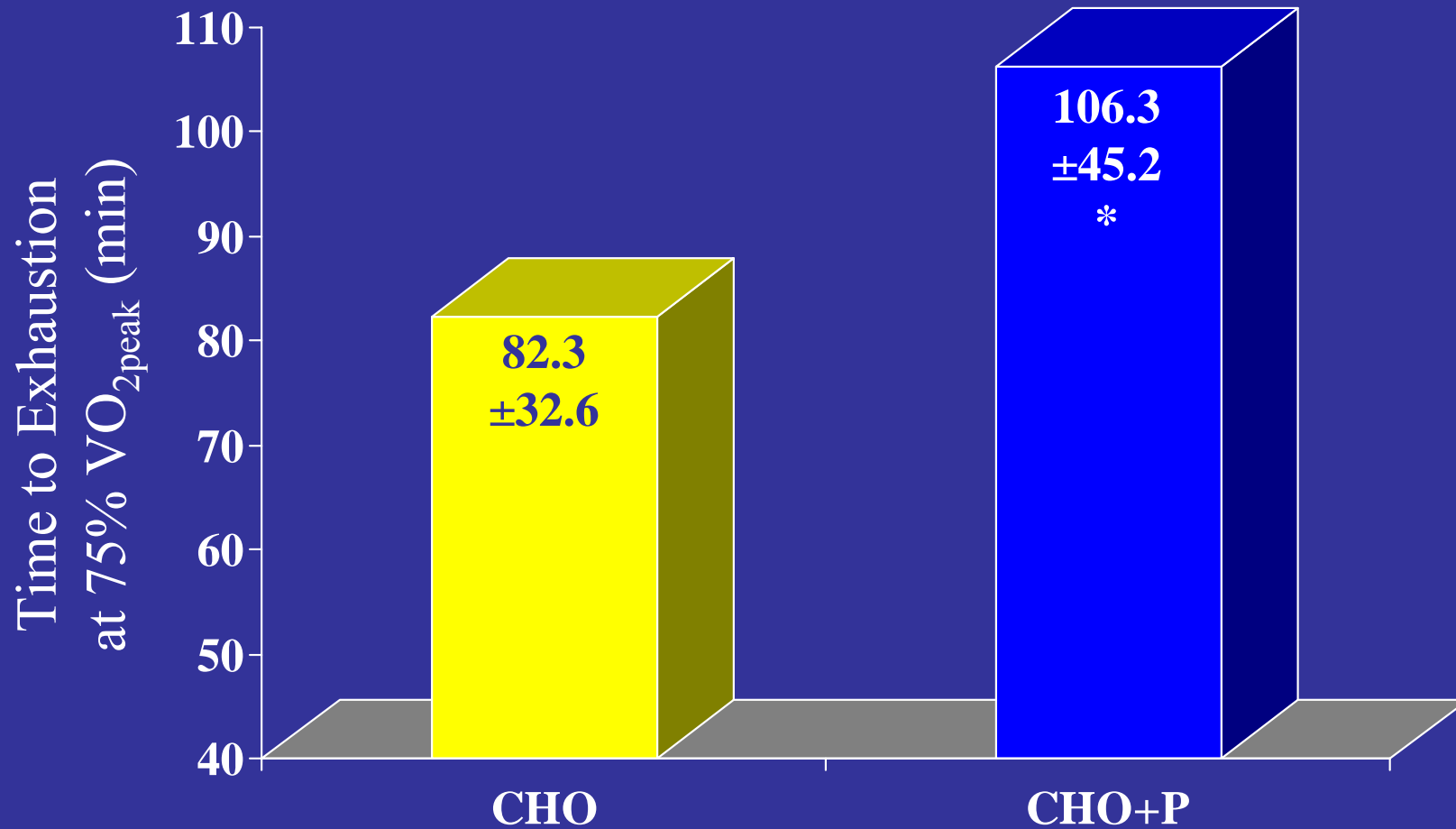


* Significantly longer than placebo

** Significantly longer than CHO trial

Ivy et al., *Int J Sports Nutr Exerc Metab*, 13, 382-395, 2003.

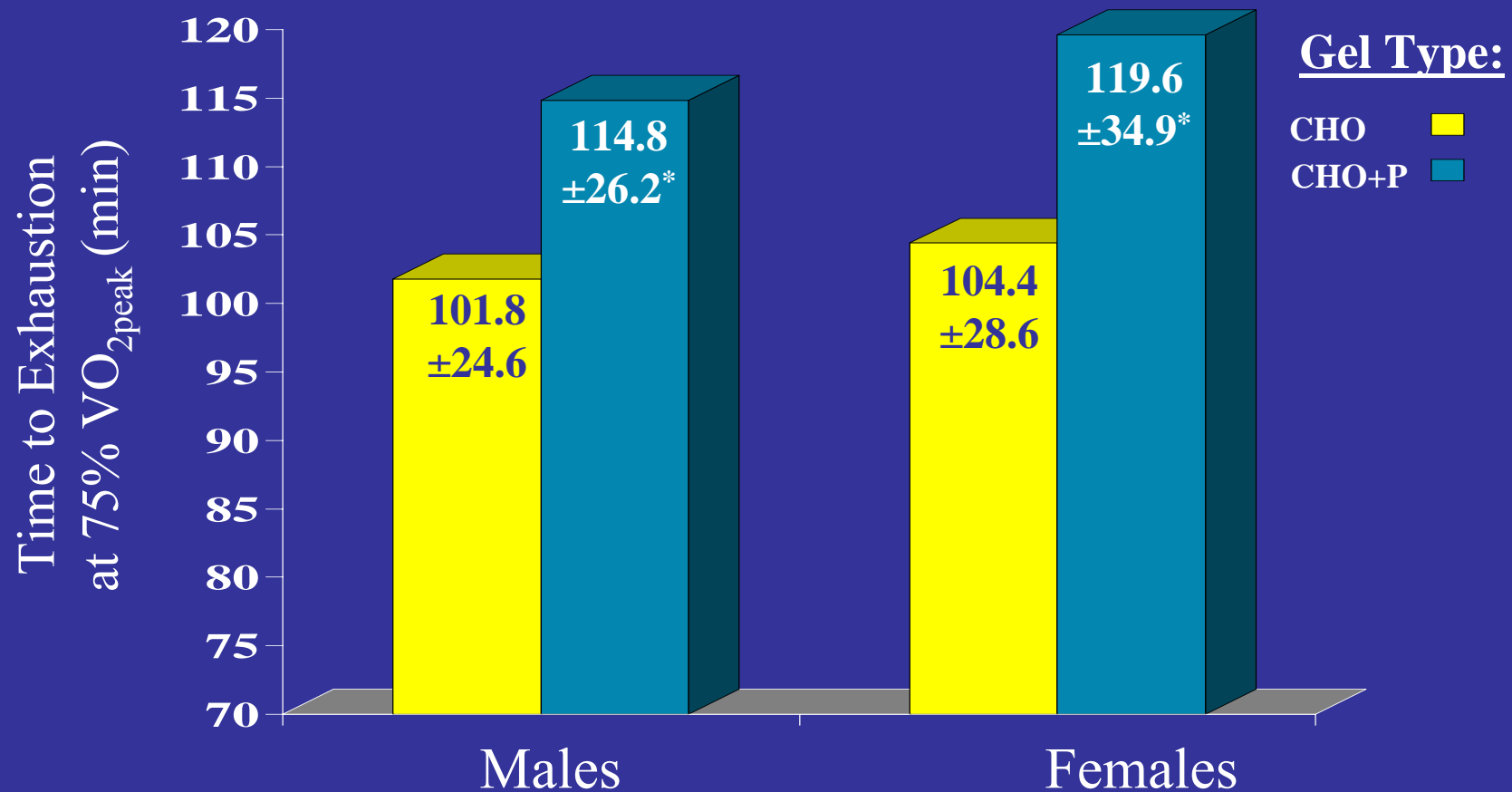
CHO+P Beverages: Effects on Endurance Performance



* Significantly longer than CHO trial

Saunders, Kane & Todd. *Med Sci Sports Exerc*, 36(7), 1233-1238, 2004.

CHO+P Beverages: Effects on Endurance Performance



* Significantly longer than CHO trial

Saunders et al., *J Intl Soc Sports Nutr*, 2(1), 17, 2005.

CHO+P & Cycling Performance

Are Improvements in Endurance Performance Observed when...

a) Time-trial measure is used instead of time-to-exhaustion?

b) Carbohydrate levels approximate maximal exogenous oxidation levels?

- 200 ml every 5km of trial, (+500ml upon completion)

- CHO & CHO+P: 60g CHO/L

- (~64g CHO per hour of exercise, glucose/maltodextrin)

- CHO+P included 18g of protein hydrolysate/L

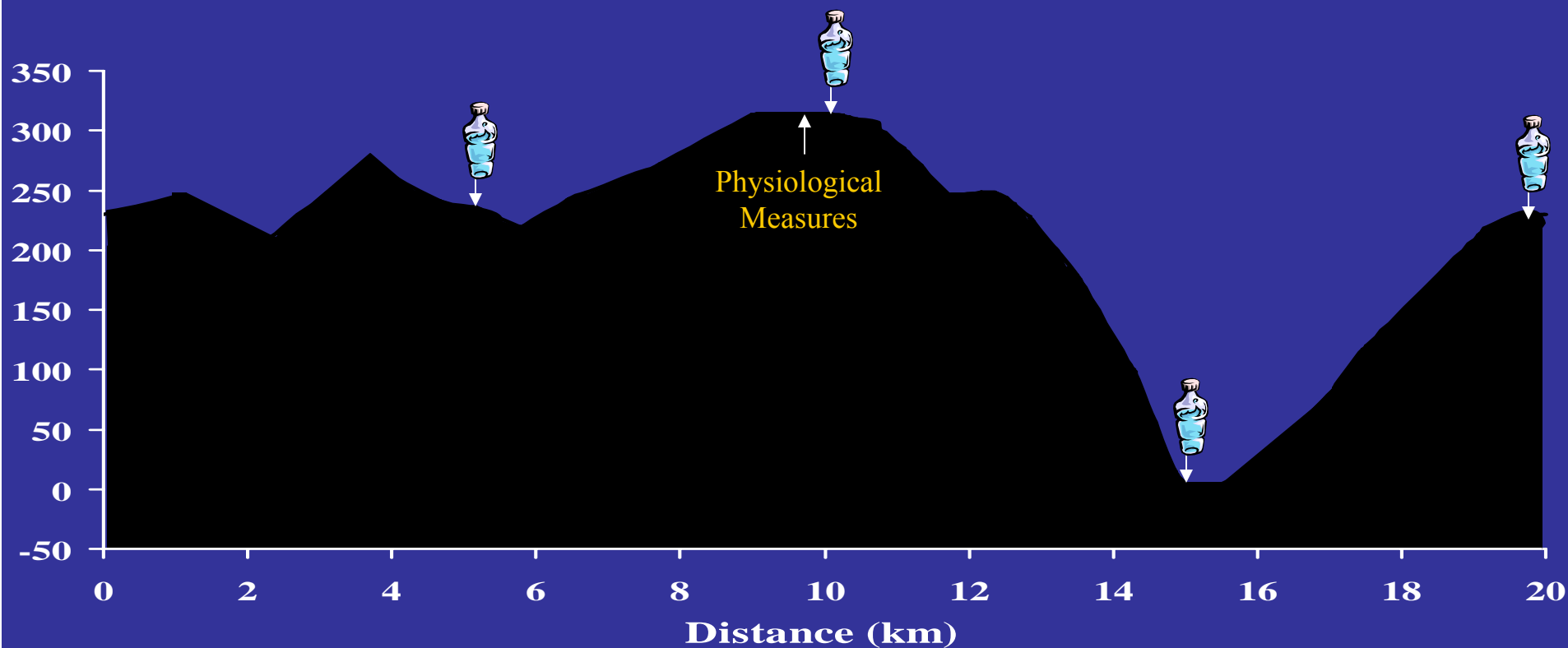
- Randomly counterbalanced, double-blind design

CHO+P & Cycling Performance

60km Course Profile

3x 20km lap, 407 vertical meters of climbing per lap

Final 5km climb ~5% average grade (8% max)

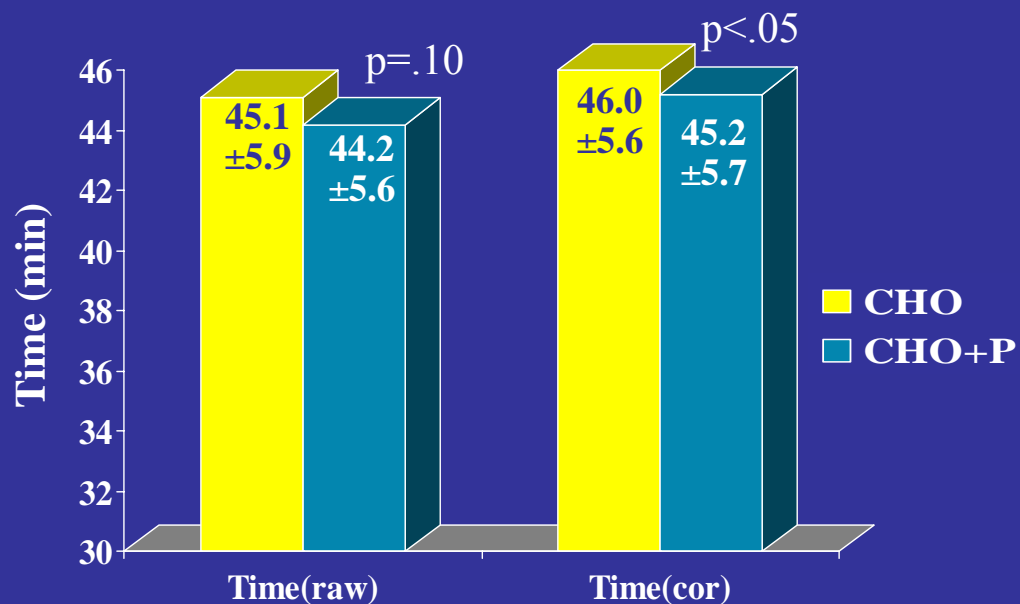


CHO+P & Cycling Performance

- 60 km Time Trial Performance:
 - 2:15:06 – CHO
 - 2:14:18 – CHO+PP
 - Mean Difference of 48 seconds
- All of the mean difference in times was observed in the final 20km of the trial
- Majority of mean difference in times was observed in final 5km hill climb
- Impact of “Order-Effect”?

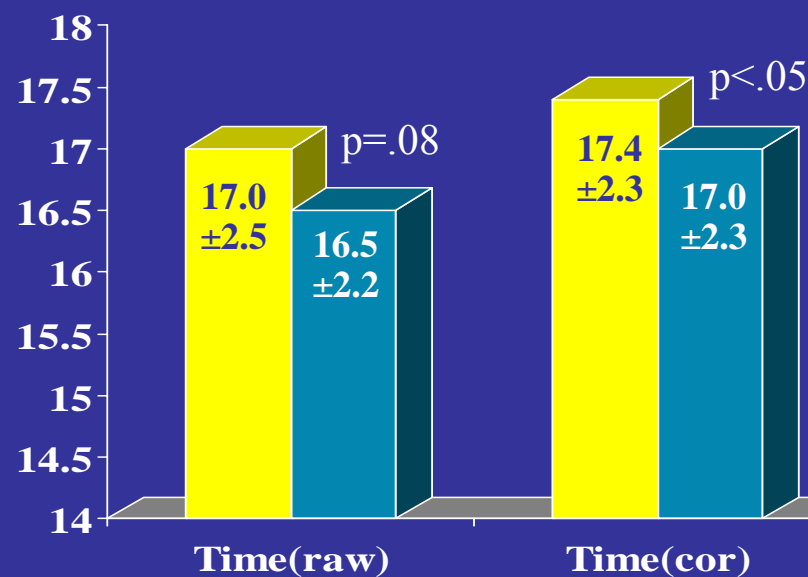
CHO+P & Cycling Performance

Final 20 km of Trial



48-54s faster in CHO+PP

Final 5 km Climb



25-30s (3%) faster in CHO+PP

Watts During Final Climb:

251.3 (CHO+P) vs. 239.9 (CHO)

CHO+P Beverages: Effects on Endurance Performance

■ Potential Mechanisms

□ Augmented plasma insulin response?

- Observed post-exercise (Van Loon et al., 2000; Zawadzki et al., 1992, others) but not during exercise
- Ivy et al. (2003) showed that CHO and CHO+P elevated insulin vs. placebo, but no difference between CHO & CHO+P (although CHO+P was 10% higher)
- Unpublished data from our lab showed a very similar response – a similar 10% elevation in CHO+P trial, which was not statistically significant

CHO+P Beverages:

Effects on Endurance Performance

■ Potential Mechanisms

□ BCAA's reducing central fatigue?

- Blomstrand et al. (1991a, 1991b) observed reduced central fatigue with BCAA administration, but numerous other studies have observed no differences with BCAA administration
- Potential benefits with protein sources with balanced groups of AA's (i.e. whole proteins, peptides)

□ Protein facilitating fluid/CHO uptake or retention?

- Shi et al. (1995) - carbohydrate and total solute absorption appeared slightly increased by the addition of glycine to a mixed-carbohydrate beverage.
- A few recent studies have suggested that hydration is improved with CHO+P ingestion (Flakoll et al., 2004; Seifert, 2005)

CHO+P Beverages:

Effects on Endurance Performance

■ Mechanisms

- Increased protein metabolism?
- Provide precursors for reactions to maintain Krebs' cycle intermediates
- Colombani et al. (1999) observed that plasma BCAA and glutamine decreased during a marathon run with CHO but were maintained or increased when run with CHO+P
 - Supplemented protein in the CHO+P treatment was absorbed and probably at least partially oxidized
- Similarly, Koopman et al. (2004) reported twofold increases in protein oxidation when CHO+P was consumed during exercise

CHO+P Beverages: Effects on Recovery & Subsequent Performance

- A few studies have demonstrated improved “subsequent” performance during CHO+P treatments
 - Niles et al., 2001
 - Saunders et al., 2004
 - Williams et al., 2003
- Proposed reasons for performance improvement
 - Improved glycogen replenishment
 - Niles et al., 2001; Williams et al., 2003.
 - Decreased muscle damage
 - Saunders et al., 2004

CHO+P Beverages:

Effects on Performance & Recovery

Phase 1

Phase 2

Phase 3

**VO_{2peak}
Test**

**Ride to
fatigue at
75%VO_{2peak}
(solution A)**

**Ride to
fatigue at
85%VO_{2peak}
(solution A)**

**Ride to
fatigue at
75%VO_{2peak}
(solution B)**

**Ride to
fatigue at
85%VO_{2peak}
(solution B)**

2-7
Days

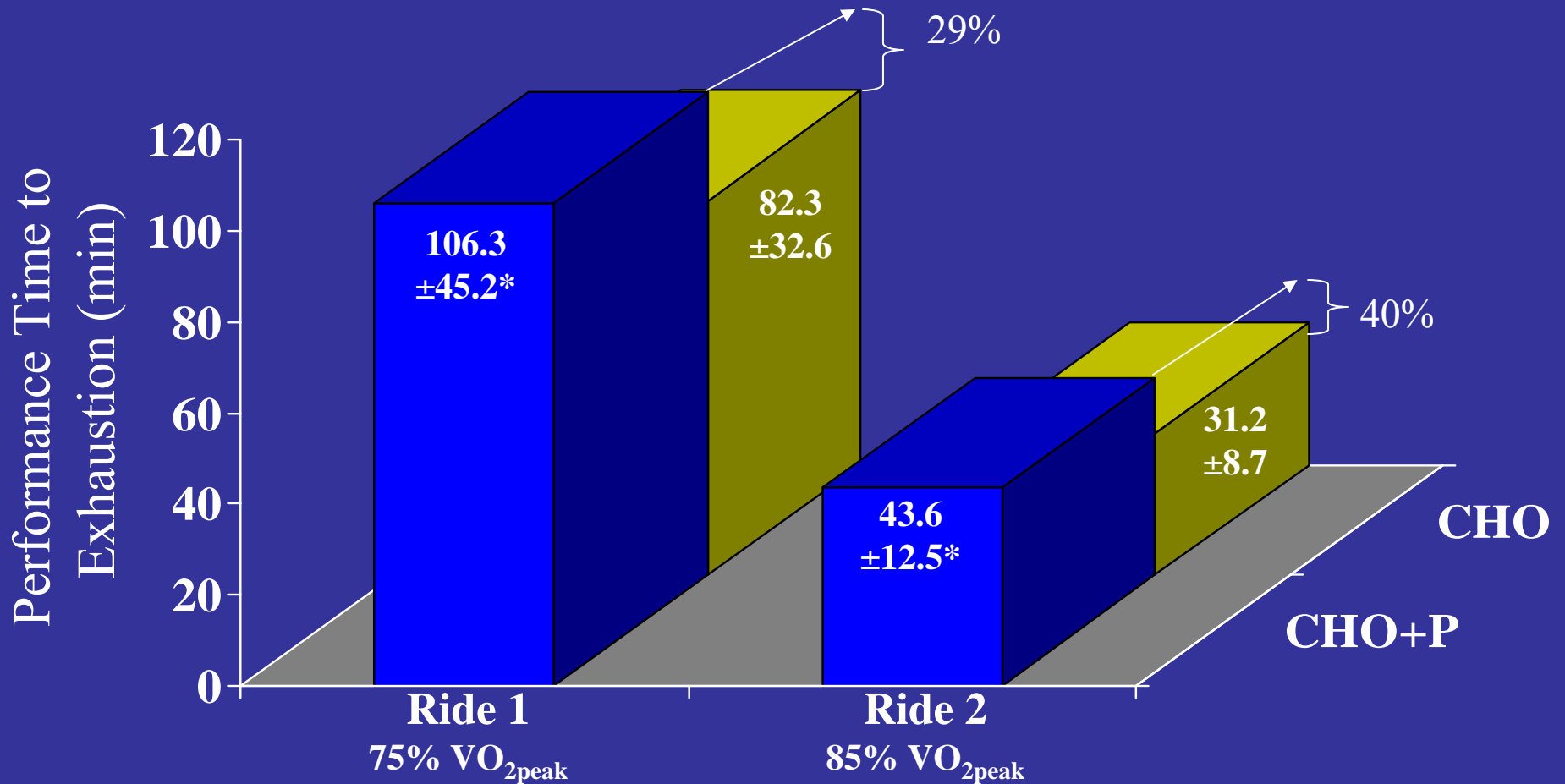
12-15 Hour
Rest Period

7-14
Days

12-15 Hour
Rest Period

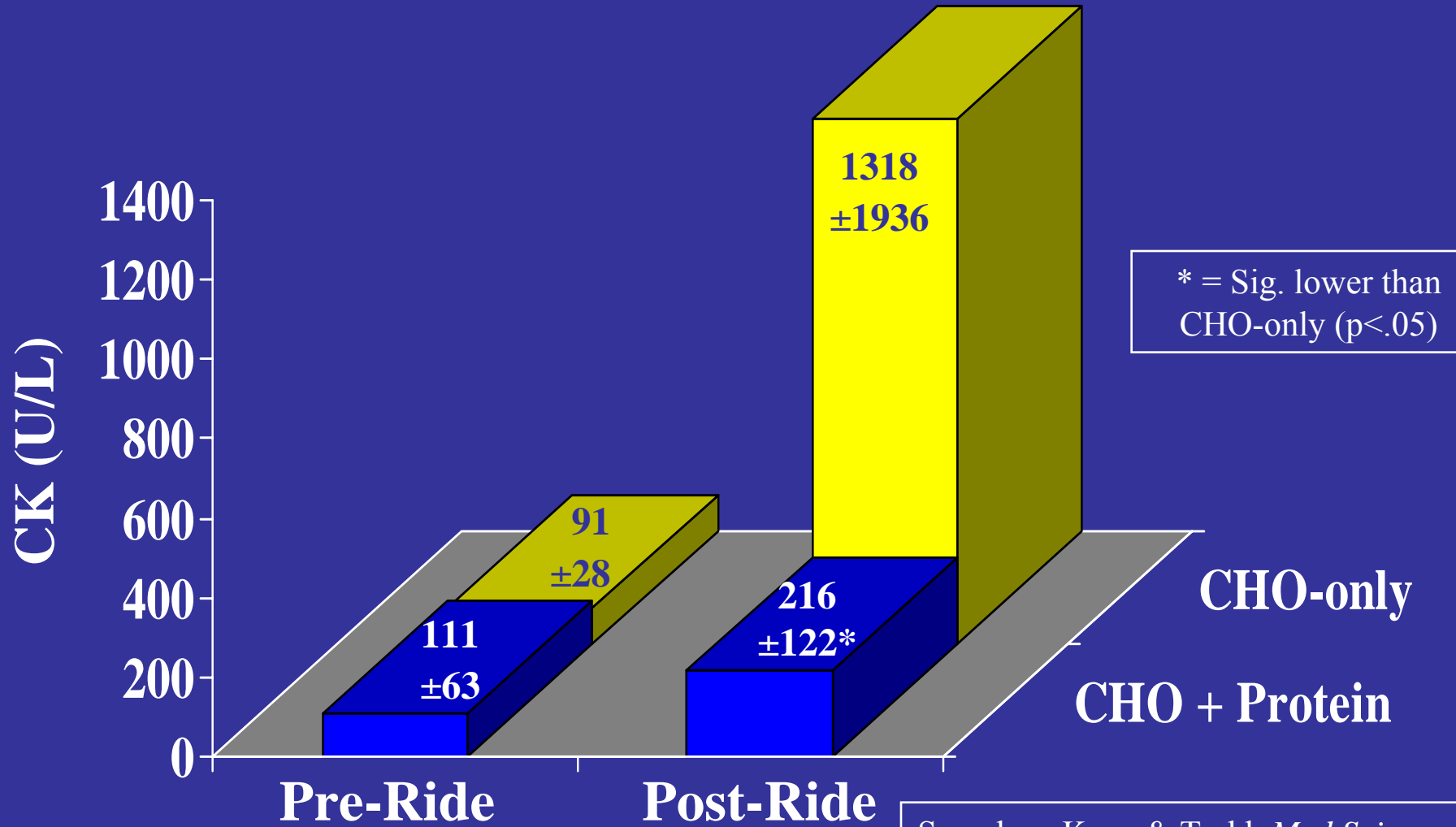
Saunders, Kane & Todd. *Med Sci Sports Exerc*, 36(7), 1233-1238, 2004.

CHO+P Beverages: Acute & Subsequent Performance



Saunders, Kane & Todd. *Med Sci Sports Exerc*, 36(7), 1233-1238, 2004.

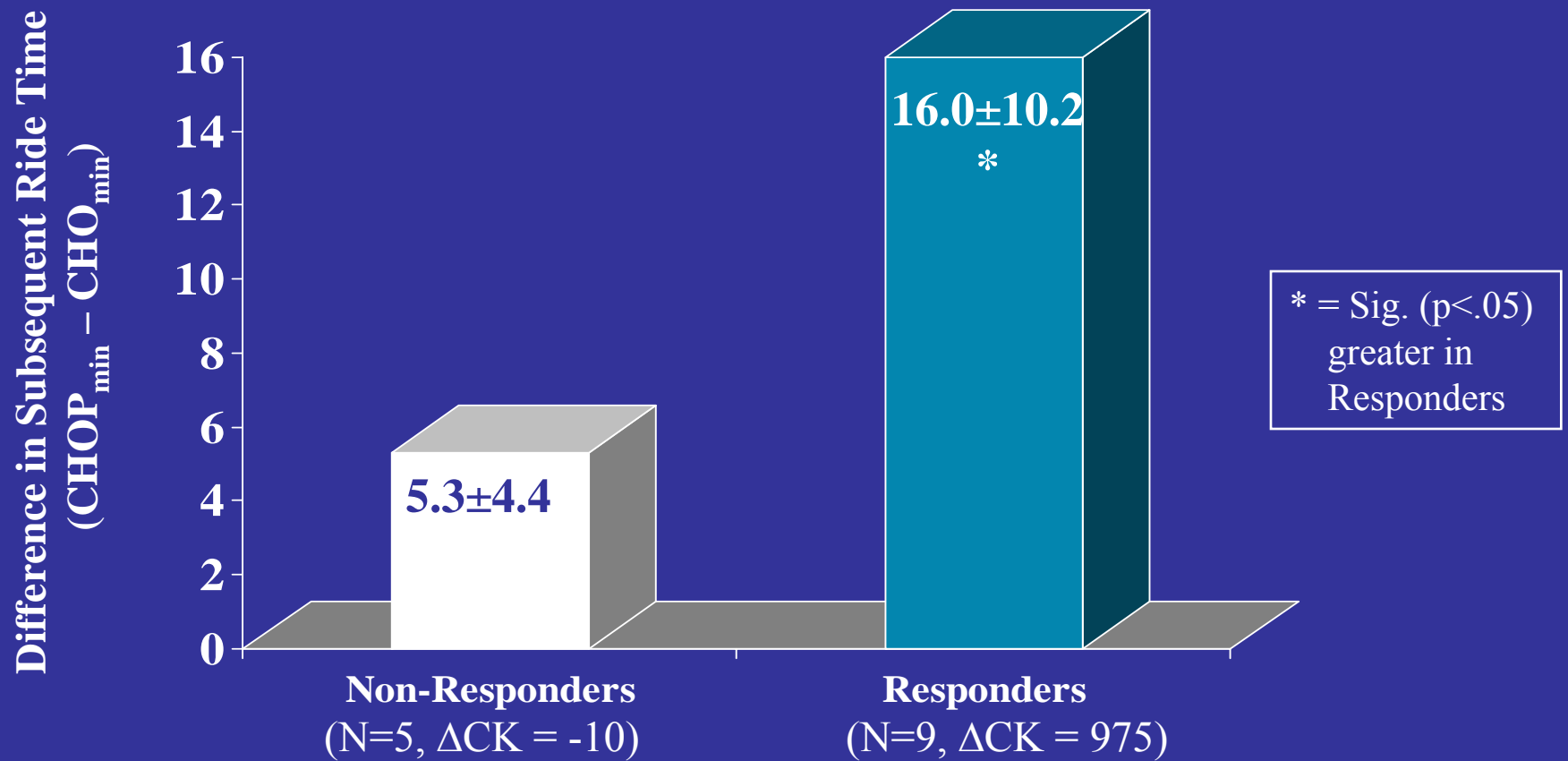
CHO+P Beverages: Muscle Damage



Saunders, Kane & Todd. *Med Sci Sports Exerc*, 36(7), 1233-1238, 2004.

CHO+P Beverages & Muscle Damage

- Does attenuated muscle damage influence subsequent performance?



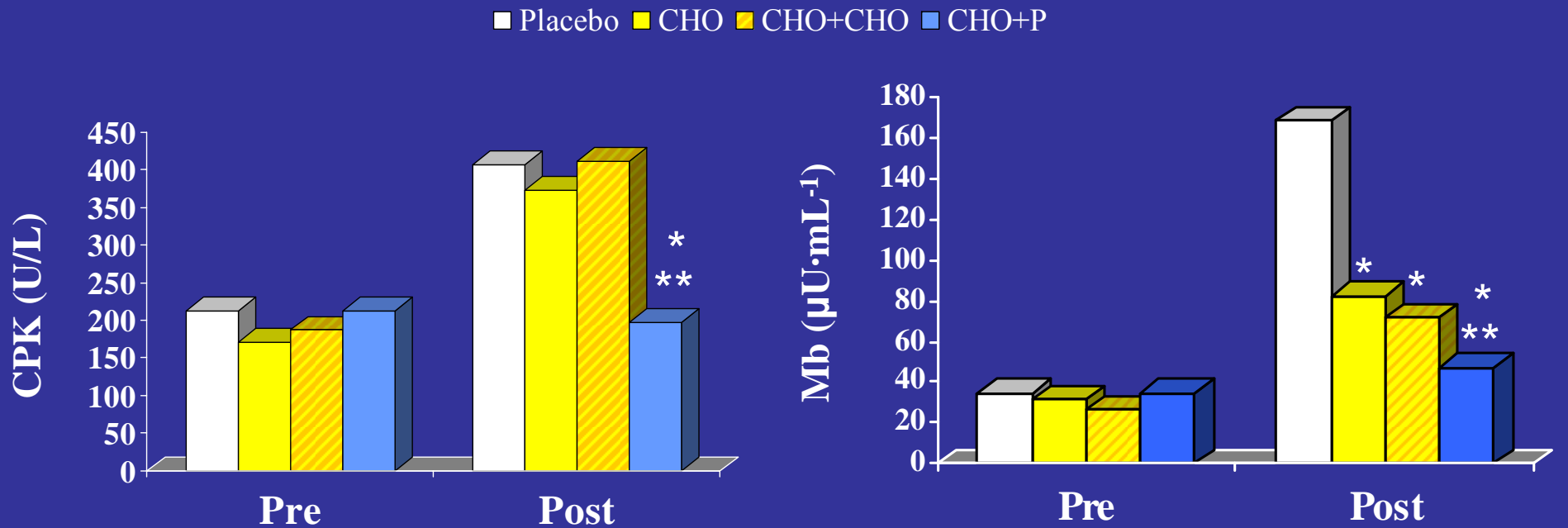
Combest, Saunders, Kane & Todd. *Med Sci Sports Exerc*, 37(5): S43, 2005.

CHO+P Beverages & Muscle Damage

Criticisms of the previous data:

- 1) Use of CK as the sole marker of muscle damage. Do other markers of muscle damage exhibit similar responses?
- 2) Are attenuations in muscle damage the result of CHO+P consumed during exercise, following-exercise, or both?
- 3) Impact of “other” ingredients between treatments beverages?

CHO+P Beverages & Muscle Damage



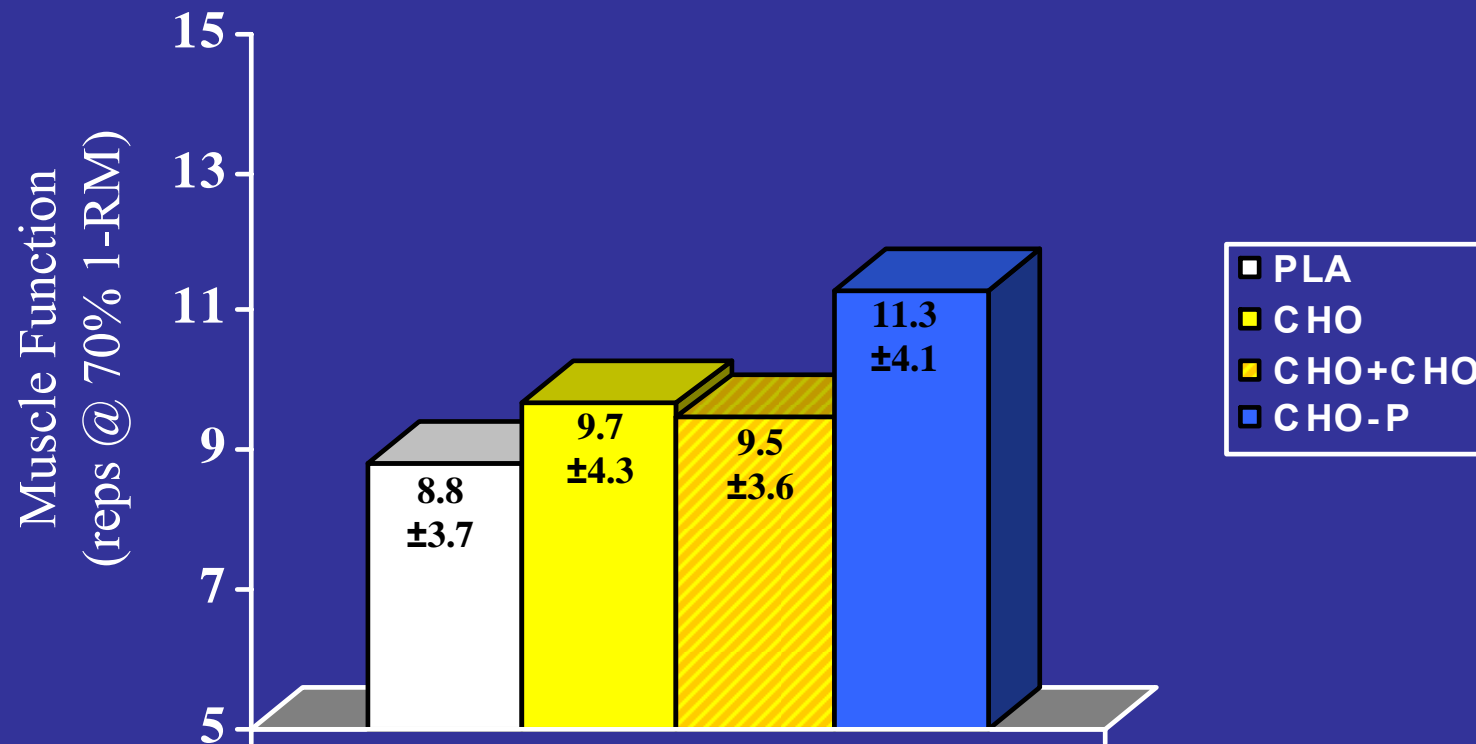
* = significantly lower than placebo (p<.05)

** = significantly lower than all other treatments (p<.05)

- Beverage consumed during-exercise only
- Beverages matched on all ingredients except protein

St. Laurent et al. *Med Sci Sports Exerc*, 36(5): [ACSM, 2006].

CHO+P Beverages & Muscle Damage



- Beverage consumed during-exercise only
- Beverages matched on all ingredients except protein

St. Laurent et al. *Med Sci Sports Exerc*, 36(5): [ACSM, 2006].

Post-Exercise CHO+P & Muscle Damage

	Training	Diet	
		CHO	CHO+P
Sun	15-32 km long run		
Mon	30-minutes light resistance training 10 km easy running	Energy (kcal)	2,270 ± 573
Tues	Intervals of varied length on a rolling cross-country course	Carbohydrates (kcal)	1,260 ± 336
Wed	10 km easy		
Thurs	30-minutes light resistance training 15 km moderate on hilly terrain	Protein (kcal)	341 ± 95
Fri	8-10 km easy		
Sat	5-8 km cross-country race		

Note: Not including nutrients from treatments.

6-day, DB randomly counterbalanced post-ex treatment intervention:

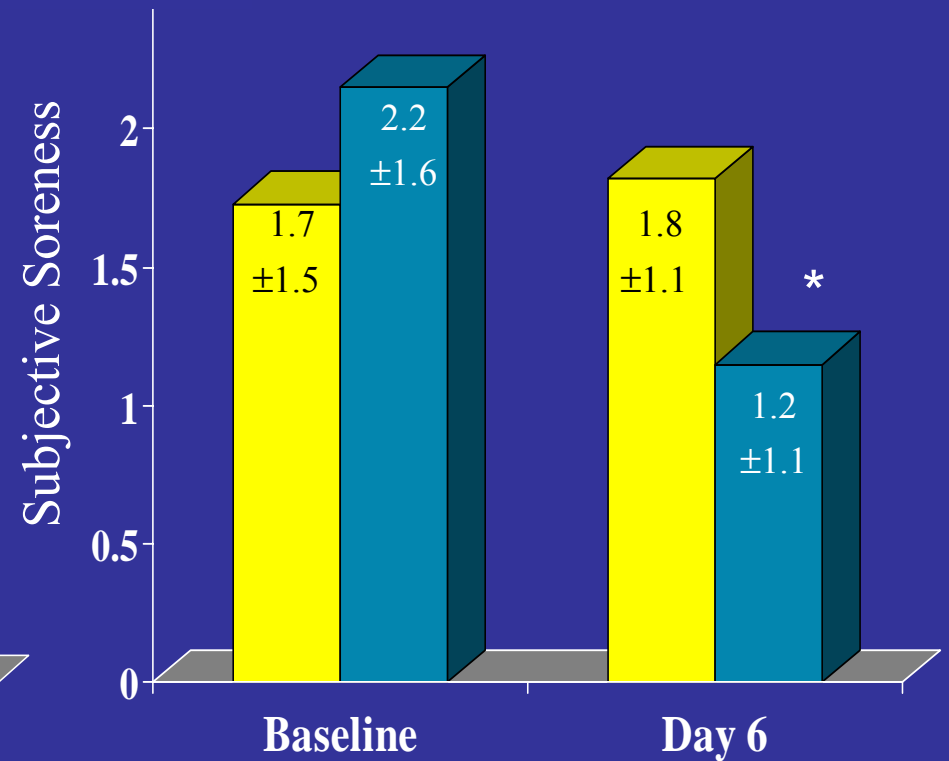
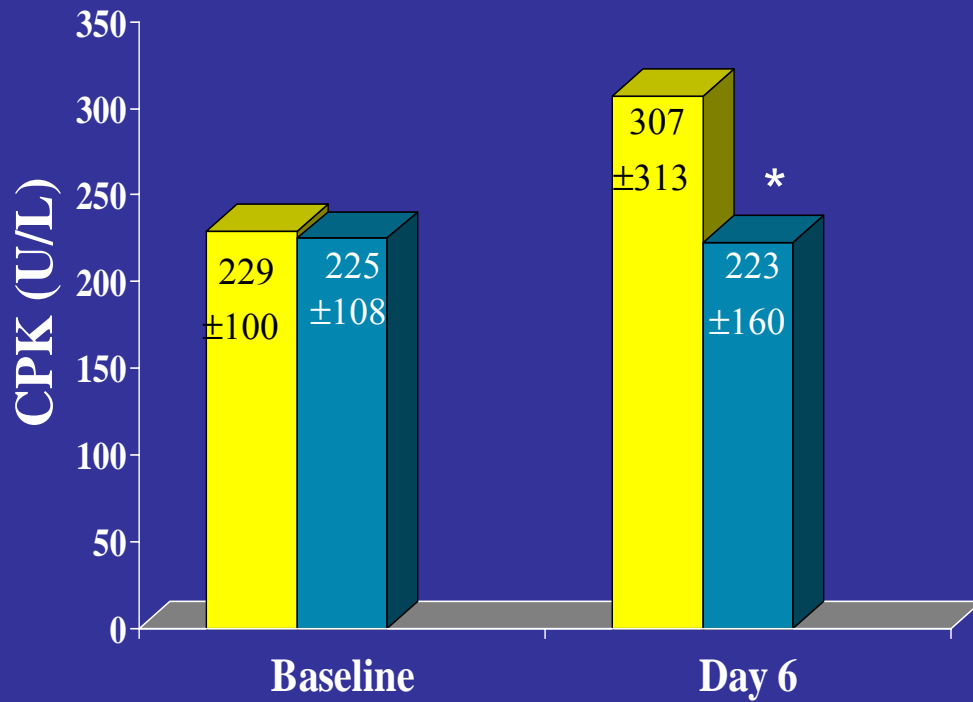
Following each run, subjects consumed 10 ml·kgBW⁻¹ of beverage:

CHO = 1.46g·kgBW⁻¹ CHO

CHO = 1.46g·kgBW⁻¹ CHO + 0.365g·kgBW⁻¹ whey protein

Post-Exercise CHO+P & Muscle Damage

■ CHO ■ CHO+P

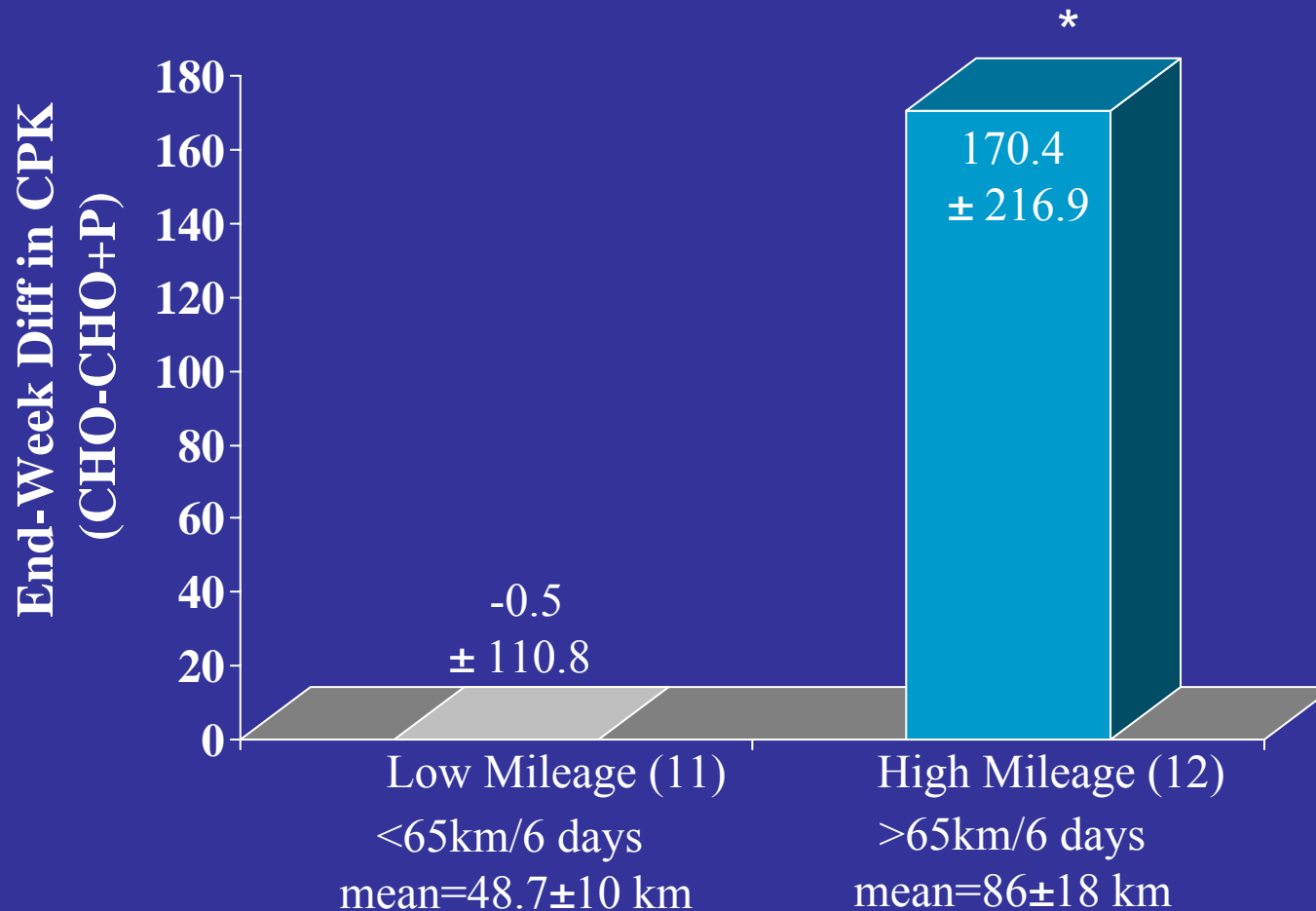


* = Sig. lower than CHO-only ($p < .05$)

Luden et al. *Med Sci Sports Exerc*, 36(5): [ACSM, 2006].

Post-Exercise CHO+P & Muscle Damage

Effects of Volume of Training

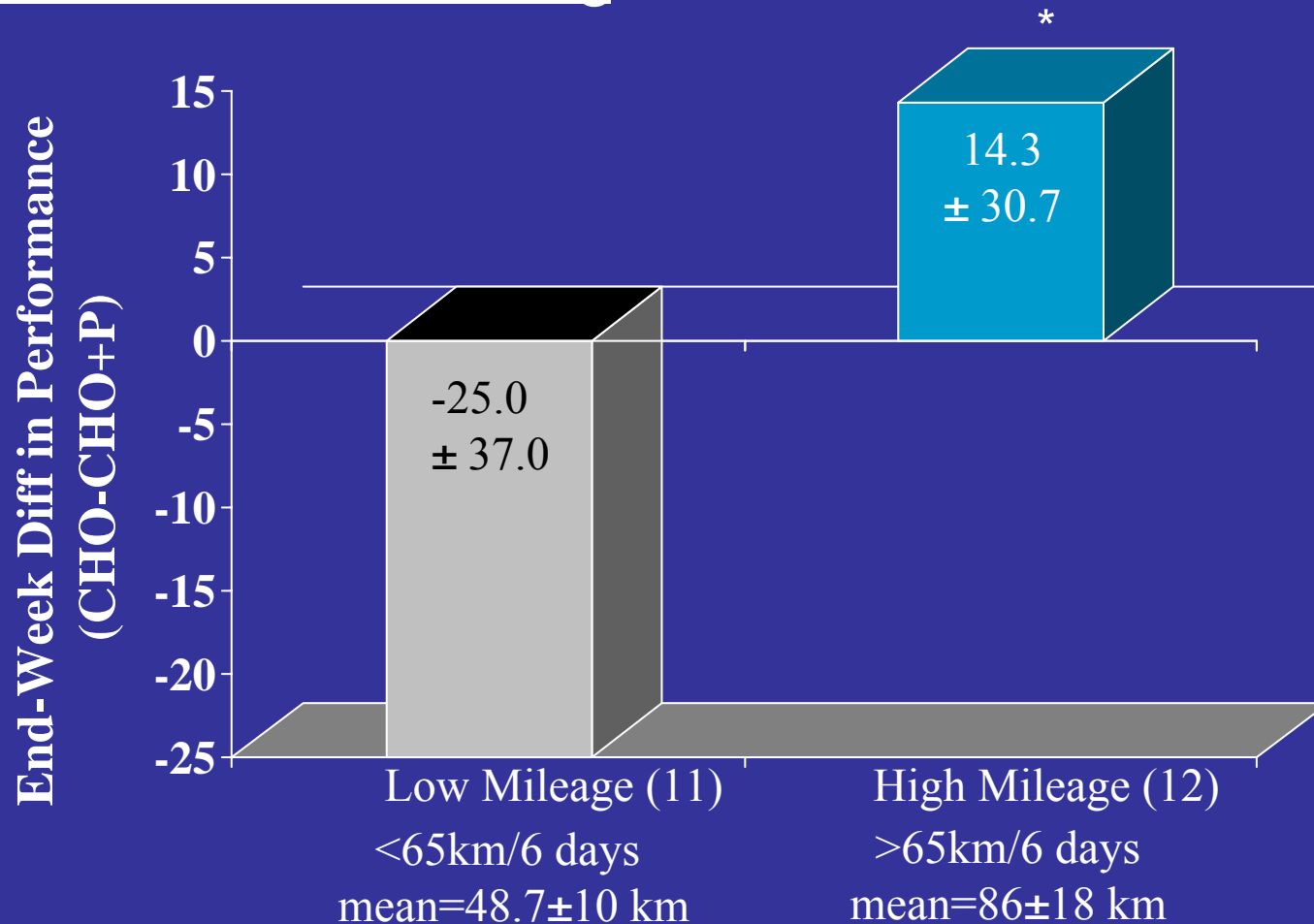


* = Treatment*volume interaction (p<.05)

Luden et al. *Med Sci Sports Exerc*, 36(5): [ACSM, 2006].

Post-Exercise CHO+P & Muscle Damage

Effects of Volume of Training



* = Treatment*volume
interaction (p<.05)

Luden et al. *Med Sci Sports
Exerc*, 36(5): [ACSM, 2006].

CHO+P & Muscle Damage: Potential Mechanisms

- CHO+P improves the balance between protein synthesis and degradation
 - Miller et al. (2003)
 - Significantly greater post-exercise leg phenylalanine uptake following post-exercise CHO+P ingestion than CHO or protein intake alone.
 - CHO-induced hyperinsulinemia was inadequate for protein synthesis without an adequate supply of amino-acids.
 - Presence of CHO and protein provides an optimal combination for post-exercise protein synthesis.
 - Koopman et al. (2004)
 - CHO+P ingestion improved protein balance at rest, during endurance exercise, and post-exercise.
 - Whole body protein degradation was reduced by approximately 60% when CHO+P was consumed, compared to CHO

CHO+P & Muscle Damage: Nutrient Timing

- Importance of timing of CHO+P ingestion:
 - Levenhagen et al. (2001)
 - Protein synthesis and net protein balance significantly greater when CHO+P supplements consumed immediately following exercise compared to 3 hours post-exercise.
 - Esmarck et al. (2001)
 - Immediate post-exercise consumption of protein/carbohydrate supplement yielded significantly greater muscle hypertrophy in elderly adults following resistance training than when protein intake was delayed 2-hours following exercise.

CHO+P Beverages:

Summary of Effects on Performance

- Addition of protein to carbohydrate sports drinks improves prolonged endurance performance
 - Time to exhaustion is improved
 - Time/power enhanced in the late-stages of time-trials
 - Benefits observed at CHO ranges from ~30-60+ g/hr
 - Benefits observed with whey protein and protein peptides

CHO+P Beverages:

Summary of Effects on Recovery

- Addition of protein to carbohydrate sports drinks improves muscle recovery & subsequent exercise
 - Post-exercise muscle damage is reduced
 - Attenuated post-exercise CPK, myoglobin, LDH
 - Post-exercise muscle soreness is reduced
 - Improvements observed when CHO+P is consumed during and/or immediately post-exercise
 - Athletes who are susceptible to the greatest muscle damage may derive the greatest subsequent benefits
 - Other aspects of muscle recovery may also be enhanced (muscle glycogen replenishment, etc.)

Questions?

