NSCA®
NATIONAL STRENGTH AND CONDITIONING ASSOCIATION

# 2019 NSCA PERSONAL TRAINERS VIRTUAL CONFERENCE

**OCTOBER 7 – 11**

#NSCAPT19

# *Carbohydrates Periodization for Performance*

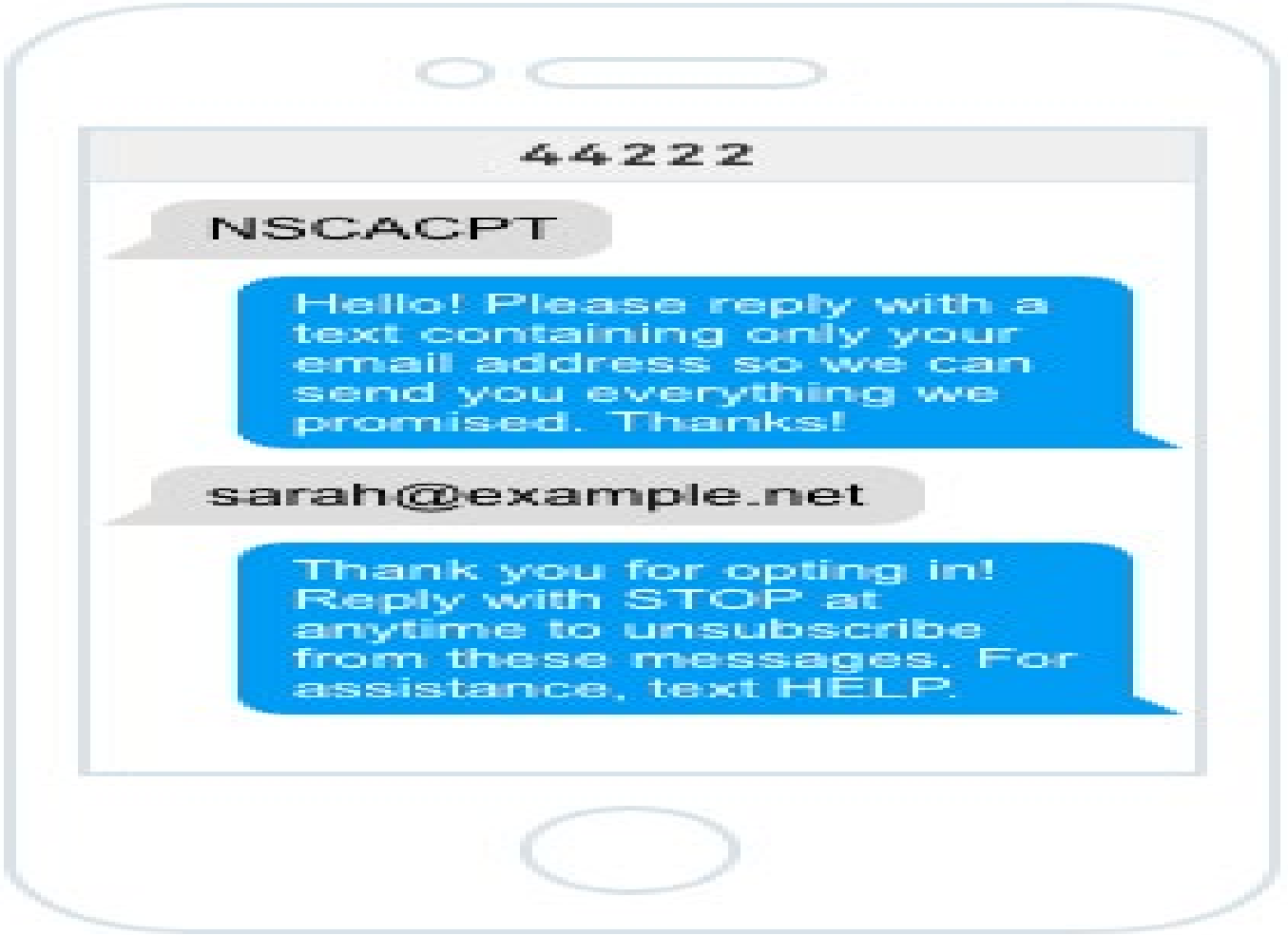
Mike T Nelson, PhD, CSCS,*D

# *CONFLICT OF INTEREST STATEMENT*

I have no actual or potential conflict of interest in relation to this presentation.

# *CARBS*

# *SLIDES & EXTRAS*



# BENEFITS

- Use to power more intense exercise
- Inexpensive fuel
- May modify stress response (insulin vs cortisol)
- Micronutrition
- Tasty

# *CARBS*

- Stored as glycogen
  - Liver and muscle
  - Limited energy
  - Blood glucose is very limited
- Can’t drive muscle glycogen to zero
- Muscle glycogen influenced by work done
- Studied for decades – still more to learn
- Weight training / HIIT?  Carbs are your friend

https://pixabay.com/photos/rice-white-rice-korea-food-3997767/

# Lift Stuff with Carbz

# NSCA PTQ JOURNAL

## CARBOHYDRATE PERIODIZATION—PART 1: FUELING EXERCISE

MIKE NELSON, PHD, CSCS, CISSN

# *CARBS*

## Stored Glucose and Glycogen

The average 150-pound (68-kilogram) male has about 1,800 calories of carbohydrates stored in the liver, muscles, and blood in approximately the following distribution:

| | |
|---|---|
| Muscle glycogen | 1,400 calories |
| Liver glycogen | 320 calories |
| Blood glucose | 80 calories |
| **Total** | **1,800 calories** |

# *McARDLE'S DISEASE*

*"The possible incidence of the syndrome is hard to come by, but in certain areas it may be about 1 in 100,000." -DiMauro S*

- Deficiency of muscle glycogen phosphorylase
- Glycogen phosphorylase breaks up glycogen into glucose subunits
- No breaking, no fuel
- Break / Burn (BB)

DiMauro S, Andreu AL, Bruno C, Hadjigeogiou GM. (2002)Myophosphorylase deficiency (glycogenosis type V; McArdledisease). Curr Mol Med 2: 189–196.

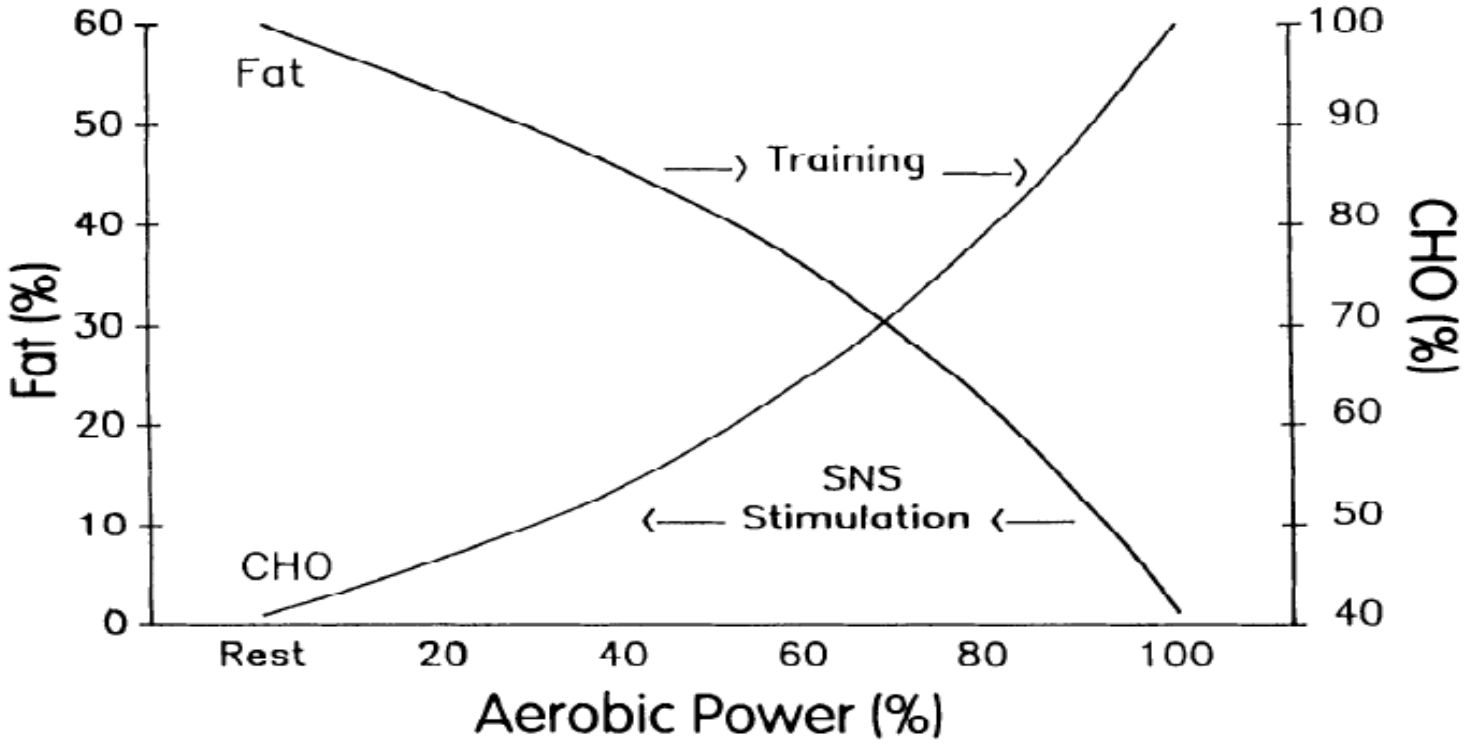
# *McARDLE'S DISEASE*

"Exercise intolerance with premature muscle fatigue, exercise-induced muscle pain in working muscles (contractures), and recurrent myoglobinuria (myoglobin in the urine)." –DiMauro S et al.


DiMauro S, Andreu AL, Bruno C, Hadjigeogiou GM. (2002)Myophosphorylase deficiency (glycogenosis type V; McArdledisease). Curr Mol Med 2: 189–196.

# *MET FLEX 101*

Crossover Effect




Brooks and Mercier 76 (6): 2253. (1994)

# *MET FLEX 101*

- Definition of Metabolic Flexibility

  *"Capacity for skeletal muscle to acutely shift its reliance between lipids and glucose during fasting or in response to insulin, such as postprandial conditions" (Sparks LM et al. 2008)*

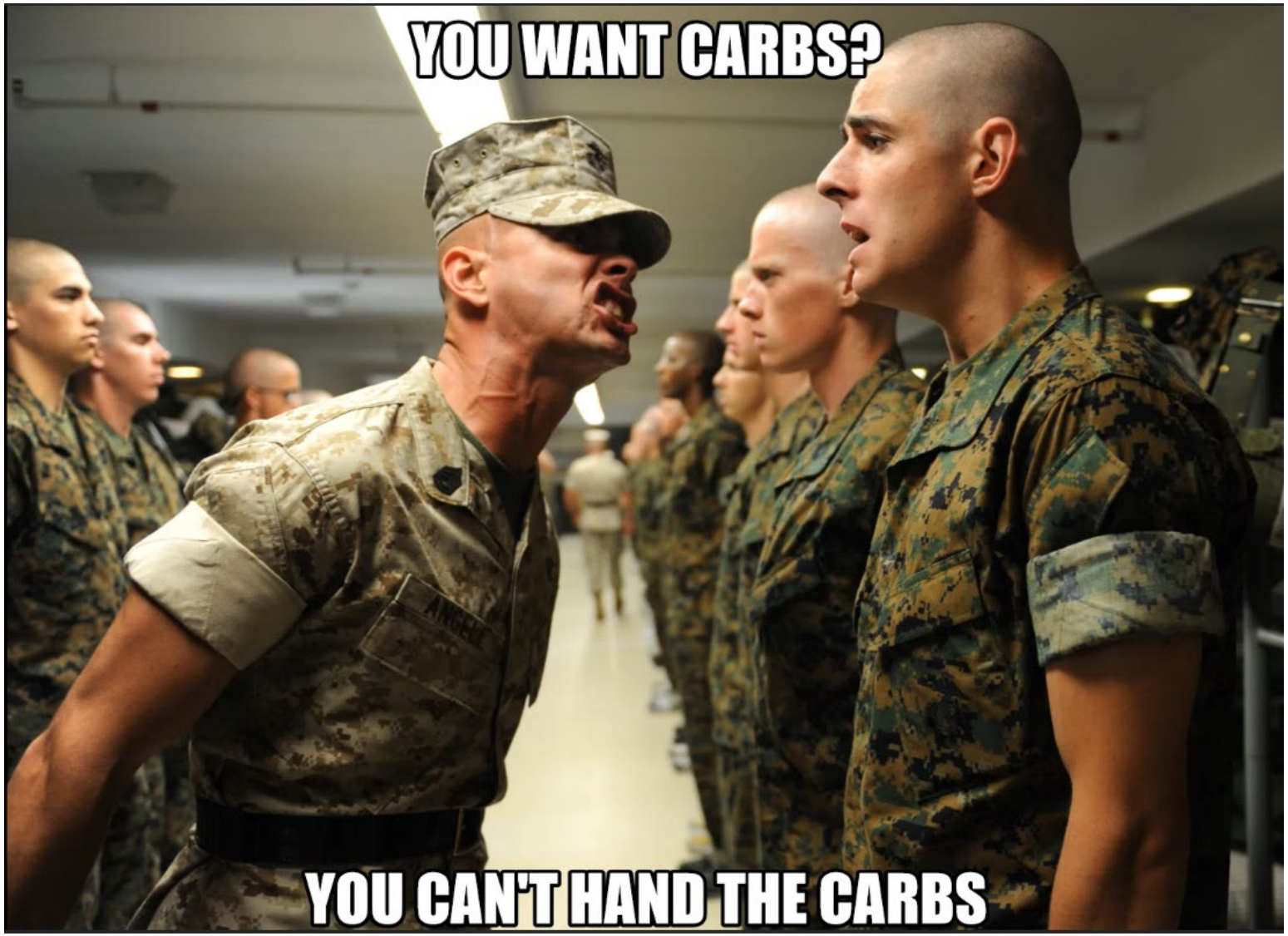
•Decrease or loss of is hypothesized to play a role in various disease processes (Kelley et al. 2000)

•Impaired fat oxidation (burning)

Sparks LM, Ukropcova B, Smith J, Pasarica M, Hymel D, Xie H, Bray GA, Miles JM, Smith SR. "Relation of adipose tissue to metabolic flexibility." Diabetes Res Clin Pract. 2009 Jan;83(1):32-43. Epub 2008 Nov 26.

Kelley DE, Mandarino LJ. "Fuel selection in human skeletal muscle in insulin resistance: a reexamination." Diabetes. 2000 May;49(5):677-83.

# *CARBS*



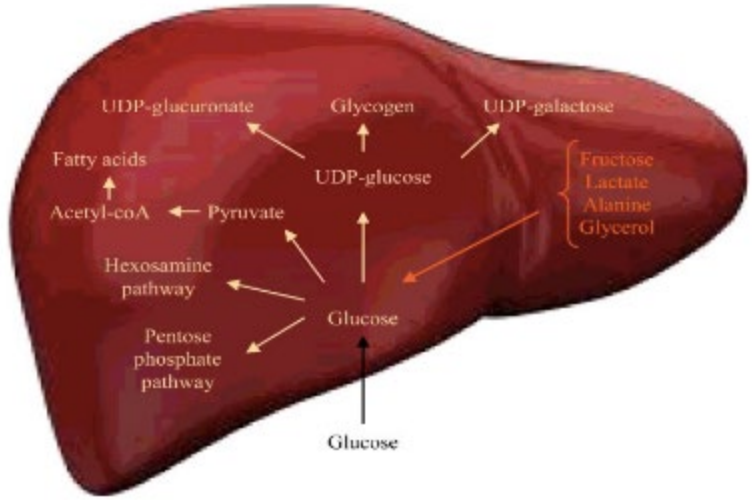
# *GLUCOSE REGULATION*

Muscle and liver

Key players

Glucose creation

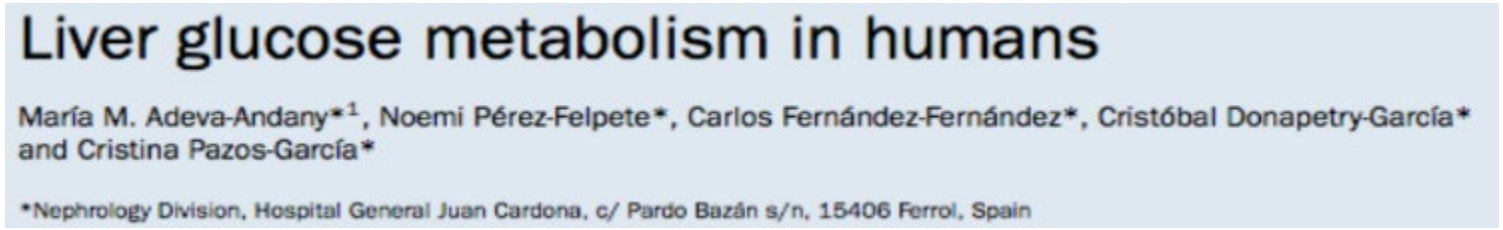
- Lactate
- AAs
- Glycerol




Biosci Rep. 2016 Dec; 36(6): e00416. Published online 2016 Nov 29. Prepublished online 2016 Oct 5. doi: 10.1042/BSR20160385 Open Access
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5293555/

# *LIVER*

*"..The contribution of gluconeogenesis (metabolic pathway that results in the generation of glucose from non-carbohydrate carbon substrates such as lactate, glycerol, and glucogenic amino acids) to hepatic glucose production increases gradually with prolonged fasting so that after approximately 42 h of fasting, gluconeogenesis accounts for almost all of glucose production in healthy subjects."*



Liver glucose metabolism in humans

María M. Adeva-Andany*[1], Noemi Pérez-Felpete*, Carlos Fernández-Fernández*, Cristóbal Donapetry-García* and Cristina Pazos-García*

*Nephrology Division, Hospital General Juan Cardona, c/ Pardo Bazán s/n, 15406 Ferrol, Spain

Biosci Rep. 2016 Dec; 36(6): e00416. Published online 2016 Nov 29. Prepublished online 2016 Oct 5. doi: 10.1042/BSR20160385 Open Access
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5293555/

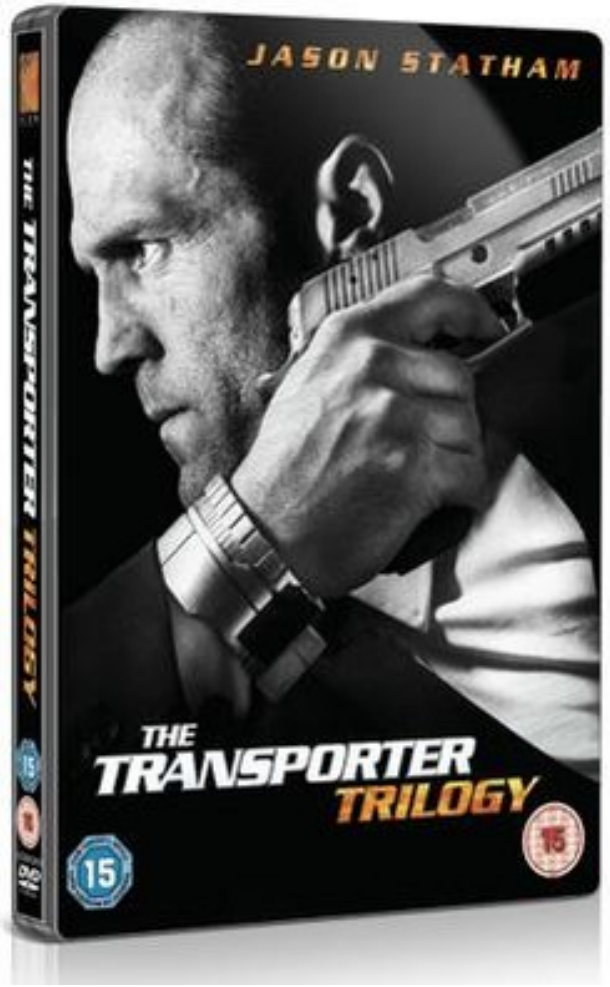
# *EXERCISE, CARBS & INSULIN*

2 Main Transporters

1) Insulin mediated
    - GLUT-4

2) Non insulin mediated

- Muscle contraction
- Movement



# *EXERCISE, CARBS & INSULIN*

Can you increase Insulin meditated transporters?

- YES!  Aerobic Training (Krotkiewski M et al, Ligtenberg PC et al.)
- 2004 study – Strength training

## Strength Training Increases Insulin-Mediated Glucose Uptake, GLUT4 Content, and Insulin Signaling in Skeletal Muscle in Patients With Type 2 Diabetes

Mads K. Holten,[1,2] Morten Zacho,[2] Michael Gaster,[3] Carsten Juel,[2,4] Jørgen F.P. Wojtaszewski,[2,5] and Flemming Dela[1,2]

Krotkiewski M, Lo¨nnroth P, Mandroukas K, Wroblewski Z, Rebuffe´-Scrive M: The effects of physical training on insulin secretion and effectiveness and on glucose metabolism in obesity and type 2 (non-insulin-dependent) diabetes mellitus. Diabetologia 28:881–890, 1985.

Ligtenberg PC, Hoekstra JB, Bol E, Zonderland ML, Erkelens DW: Effects of physical training on metabolic control in elderly type 2 diabetes mellitus patients. Clin Sci 93:127–135, 1997

# *EXERCISE, CARBS & INSULIN*

Exercise upregulates GLUT-4

Better handling of carbs

- How long?  24-48 hours?

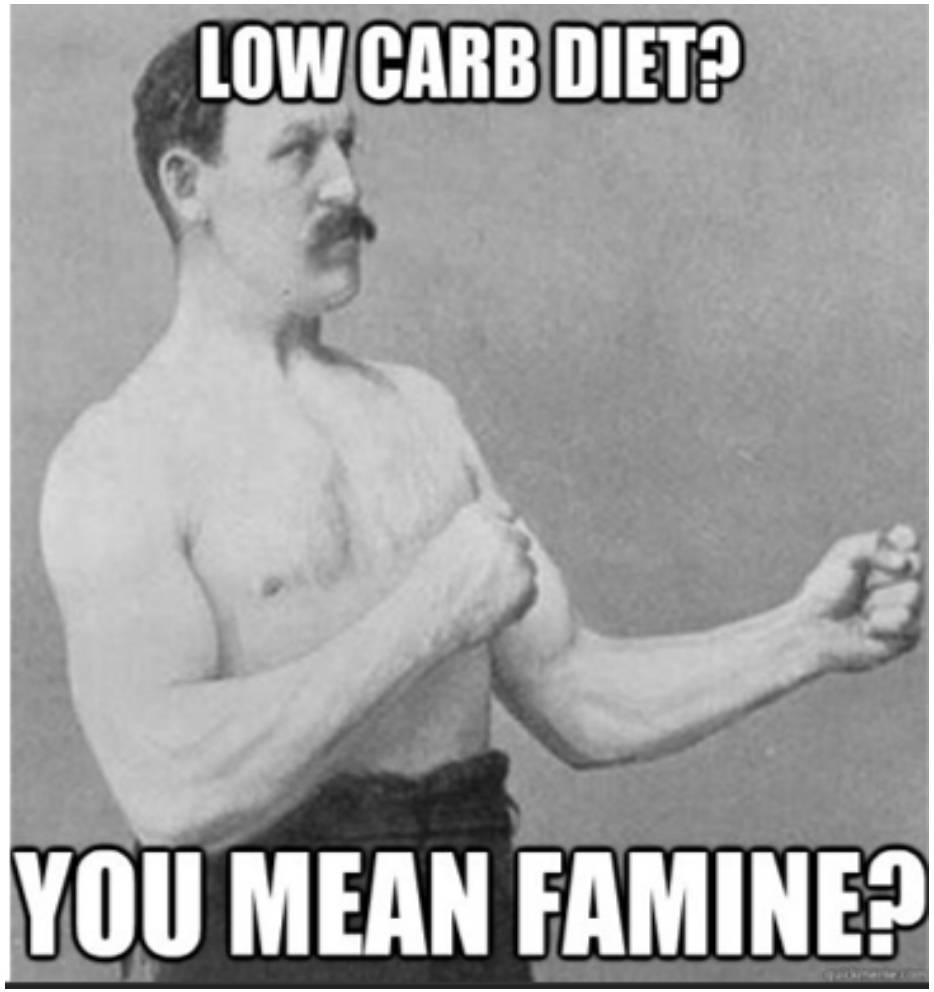
- Non-insulin mediated uptake
- In the fasting state, approximately 83% of glucose uptake occurs via non-insulin mediated mechanisms (Jumpertz R et al)
- Soskin et al.1934 →evidence for a mechanism of glucose disposal independent of insulin in pancreatectomized dogs

Jumpertz R, Thearle MS, Bunt JC, Krakoff J.  Assessment of non-insulin-mediated glucose uptake: association with body fat and glycemic status.  Metabolism. 2010 Oct;59(10):1396-401. doi: 10.1016/j.metabol.2010.01.006. Epub 2010 Feb 12.

Soskin S, Allweiss MD, Cohn DJ. Influence of the  pancreas and the liver upon the dextrose tolerance curve. American Journal of Physiology 1934;109:155–165.

# PHASE 2: LOW MUSCLE GLYCOGEN

# *CARBS*



# *ADAPTATION*

# *>*

# *PERFORMANCE*

# KETO COMEBACK?

The purpose of the Point/Counterpoint Column is to provide a respectful and balanced discussion in relation to controversial or current topics in the fields of strength and conditioning, nutrition, and human performance.

COLUMN EDITOR: Andrew J. Galpin, PhD, CSCS, NCSA-CPT

# A Case for and Against Ketogenic Diets in Athletes

Matthew Kavalek, BS,[1] Ryan Gannon, BS,[1] and Mike T. Nelson, PhD, MSME, CSCS[2,3]
[1]New York Medical College, Valhalla, New York; [2]Extreme Human Performance Instructor, Vadnais Heights, Minnesota; and [3]Globe University, Woodbury, Minnesota

# *FASTED STATE*

- Exercise upregulates GLUT-4
- Fasted vs non fasted during exercise

*J Physiol* 588.21 (2010) pp 4289–4302

## Training in the fasted state improves glucose tolerance during fat-rich diet

Karen Van Proeyen[1], Karolina Szlufcik[1], Henri Nielens[2], Koen Pelgrim[1], Louise Deldicque[3], Matthijs Hesselink[4], Paul P. Van Veldhoven[5] and Peter Hespel[1]

# *FASTED STATE*

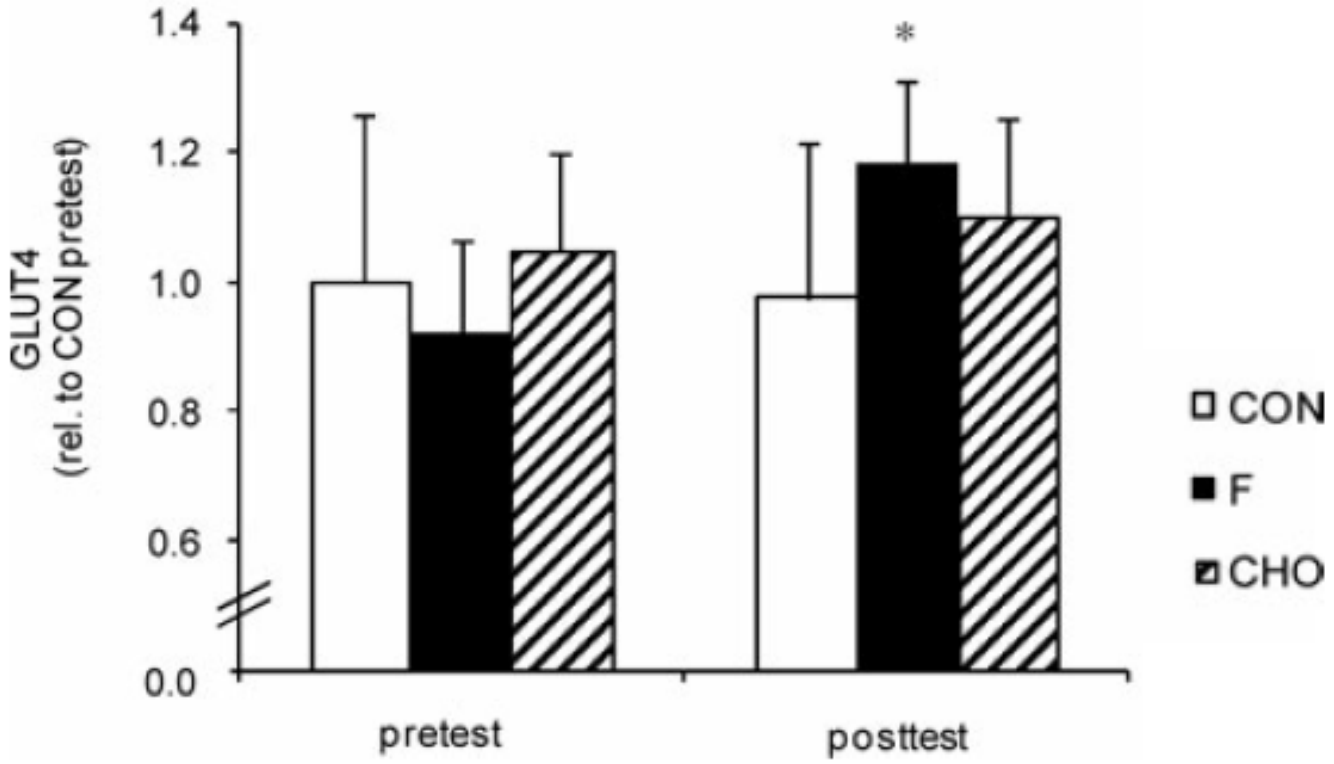
Table 1. Daily energy intake before the start of the study

| | CON | F | CHO |
|---|---|---|---|
| Energy intake (kcal day$^{-1}$) | 3081 (2018–3957) | 2911 (1951–3977) | 3012 (2011–3984) |
| % fat | 36 (26–40) | 36 (29–42) | 34 (28–38) |
| % carbohydrate | 51 (43–61) | 49 (41–58) | 52 (46–64) |
| % protein | 13 (9–18) | 15 (10–17) | 14 (9–19) |

Data provided are means and range in parentheses (CON: $n = 7$; F: $n = 10$; CHO: $n = 10$), and represent average total daily energy intake and macronutrient composition of the diet during 4 days preceding the start of the study.

# *FASTED STATE*

- GLUT-4 more upregulated in fasted training
- Adaptation > performance



# *FASTED STATE*

- Body composition better?
- Adaptation > performance

**Table 4. Effect of high-fat diet, alone or in conjunction with training in either the fasted or the carbohydrate-fed state, on body weight and subcutaneous fat**

| | | CON | F | CHO |
|---|---|---|---|---|
| Body weight (kg) | Pretest | 70.9 ± 3.4 | 73.3 ± 3.1 | 70.2 ± 3.6 |
| | Posttest | 73.9 ± 3.2* | 74.1 ± 2.8 | 71.6 ± 3.4* |
| Sum skinfolds (mm) | Pretest | 134.3 ± 27.7 | 139.7 ± 11.7 | 121.2 ± 11.0 |
| | Posttest | 154.6 ± 28.3* | 141.3 ± 11.5 | 127.8 ± 11.2 |

Data provided are means ± S.E.M. (CON: $n = 7$; F: $n = 10$; CHO: $n = 10$) and represent body weight and subcutaneous fat (sum of 12 skinfolds). Values before (pretest) and after (posttest) a 6-week hyper-caloric fat-rich diet, in either the absence (CON) or the presence of training in either the fasted state (F) or the carbohydrate-fed state (CHO) are shown. (CON: $n = 7$; F: $n = 10$; CHO: $n = 10$.)
*$P < 0.05$, versus pretest.

# *CARBS*


When you vow to give up carbs and pass freshly baked bread in the supermarket

# *GLYCOGEN DEPLETION*

- Brutal!
- Lots of work to deplete muscle glycogen
- Do not replace post depletion session
- Sleep on low carbs
- Another AM session= low muscle and liver glycogen

# *RESEARCH*

## Study Summary

- Carb availability was matched to intensity of training
- Pretty high level trained athletes
- Same amount of carbs / calories
- Different timing of carbs
- 3 weeks only
- Significant improvements in
  - Submaximal cycling economy
  - Supra-maximal cycling capacity
  - And 10 km running time and body comp by 1% (DXA)

Marquet LA, Brisswalter J, Louis J, Tiollier E, Burke LM, Hawley JA, Hausswirth C. Enhanced Endurance Performance by Periodization of Carbohydrate Intake: "Sleep Low" Strategy. Med Sci Sports Exerc. 2016 Apr;48(4):663-72.

# *RESEARCH*

> > Further research needed < <

2017 study by Geil KD et al. did not agree


Gejl KD, Thams LB, Hansen M, Rokkedal-Lausch T, Plomgaard P, Nybo L, Larsen FJ, Cardinale DA, Jensen K, Holmberg HC, Vissing K, Ørtenblad N. Med Sci Sports Exerc. 2017 Dec;49(12):2486-2497

Hulston CJ, Venables MC, Mann CH, Martin C, Philp A, Baar K, Jeukendrup AE. Training with low muscle glycogen enhances fat metabolism in well-trained cyclists. ed Sci Sports Exerc. 2010 Nov;42(11):2046-55.

Yeo WK, Paton CD, Garnham AP, Burke LM, Carey AL, Hawley JA. Skeletal muscle adaptation and performance responses to once a day versus twice every second day endurance training regimens. J Appl Physiol (1985). 2008; 105(5):1462-70.

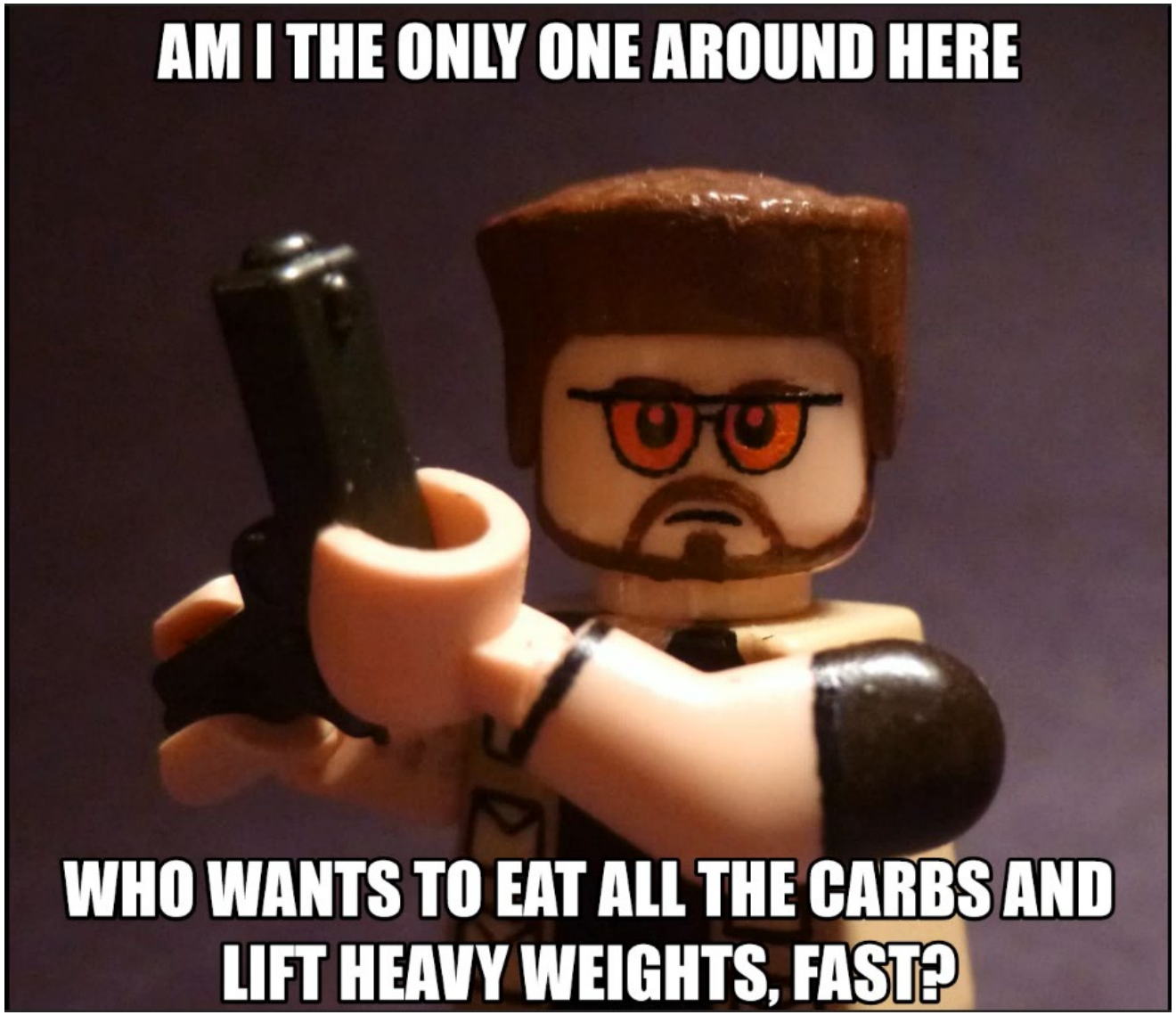
Burke LM, Ross ML, Garvican-Lewis LA et al. Low Carbohydrate, High Fat diet impairs exercise economy and negates the performance benefit from intensified training in elite race walkers. J Physiol. 2017 May 1;595(9):2785-2807.

Cochran AJ, Myslik F, MacInnis MJ, Percival ME, Bishop D, Tarnopolsky MA, Gibala MJ. Manipulating carbohydrate availability between twice-daily sessions of highintensity interval training over 2 weeks improves time-trial performance. Int J Sports Nutr Exerc Metab. 2015; 25:463-70.

Morton JP, Croft L, Bartlett JD et al. Reduced carbohydrate availability does not modulate training-induced heat shock protein adaptations but does upregulate oxidative enzyme activity in human skeletal muscle. J Appl Physiol (1985). 2009; 106(5):1513-21.

Hansen AK, Fischer CP, Plomgaard P, Andersen JL, Saltin B, Pedersen BK. Skeletal muscle adaptation: training twice every second day vs. training once daily. J Appl Physiol (1985). 2005; 98(1):93-9

# *CARBS*


AM I THE ONLY ONE AROUND HERE
WHO WANTS TO EAT ALL THE CARBS AND LIFT HEAVY WEIGHTS, FAST?

# DISTRESS TRAINING

## LOW MUSCLE GLYCOGEN

# Low *Liver*

# Glycogen

# *ADAPTATION*

# *>*

# *PERFORMANCE*

# *DISTRESS METHOD*

- Lots of work to deplete muscle glycogen
- Liver vs muscle glycogen
- Brutal!
- Do not replace post depletion session
- Sleep on low carbs
- Another AM session= low muscle and liver glycogen

# *IMMUNE RESPONSE*

# MATCHED MACROS (MM)

## Eustress Model: Phase 1

- Intense exercise
  - Use carbs → nutrition
  - Higher insulin
- Low Intensity
  - Use fat → fasted
  - Lower insulin

# *MisMATCHED MACROS (MmM)*

## Distress Model: Phase 2

- Intense exercise
  - Fasted intense exercise
  - Glycogen levels
  - Liver = AM fasted
  - Muscle = depletion work first

# *EUSTRESS: WEEKLY TEMPLATE*

- MWF = Weight Training (anaerobic)
  - Carbs around training
  - Full body (or Wed “Dude Brah” hypertrophy)
  - Goal = carb use, build muscle/ strength, mTOR1

- T, Th, Sat = Aerobic Training
  - LSD man (long slow distance)
  - Fasted
  - → or higher fat day
  - Moderate heart rate (110-140 bpm)
  - Goal = fat use, recovery (parasymp), AMPK
  - Fasting on this day is an option

# *YEARLY BLOCK*

- In Season: Matched Macros
  - Carbs around training
  - Higher carbs overall
  - Titrate up
  - Goal = carb use, build muscle/ strength, mTOR1

- Off Season: MisMatched Macros
  - Remove carbs around training on purpose
  - Lower carbs overall
  - Fasting on this day is an option
  - Goal = fat use, AMPK, enzyme changes

# CONFUSED


What do I do?
The volcano known as Eyjafjallajökull, is closest to what Icelandic city?
A: Reykjavic
B: Kopavogur
C: Hafnarfjorour
D: Fjaroabyggo

# *REVIEW*

## Eustress

- Stress you can more easily recover from
- Performance based = Macros are matched (MM)
- Most of training (> 90%)

## Distress

- Stress that is harder to recover from
- Adaptation based = Macros are mis-matched (MmM)
- Less than 10% of training

# *SUMMARY*

## Enhance carb *and* fat use

--Right fuel at the right time = met flex

## Eustress Model (>90%)

- MM = Macro Match
- Performance
- In-season

# *SUMMARY*

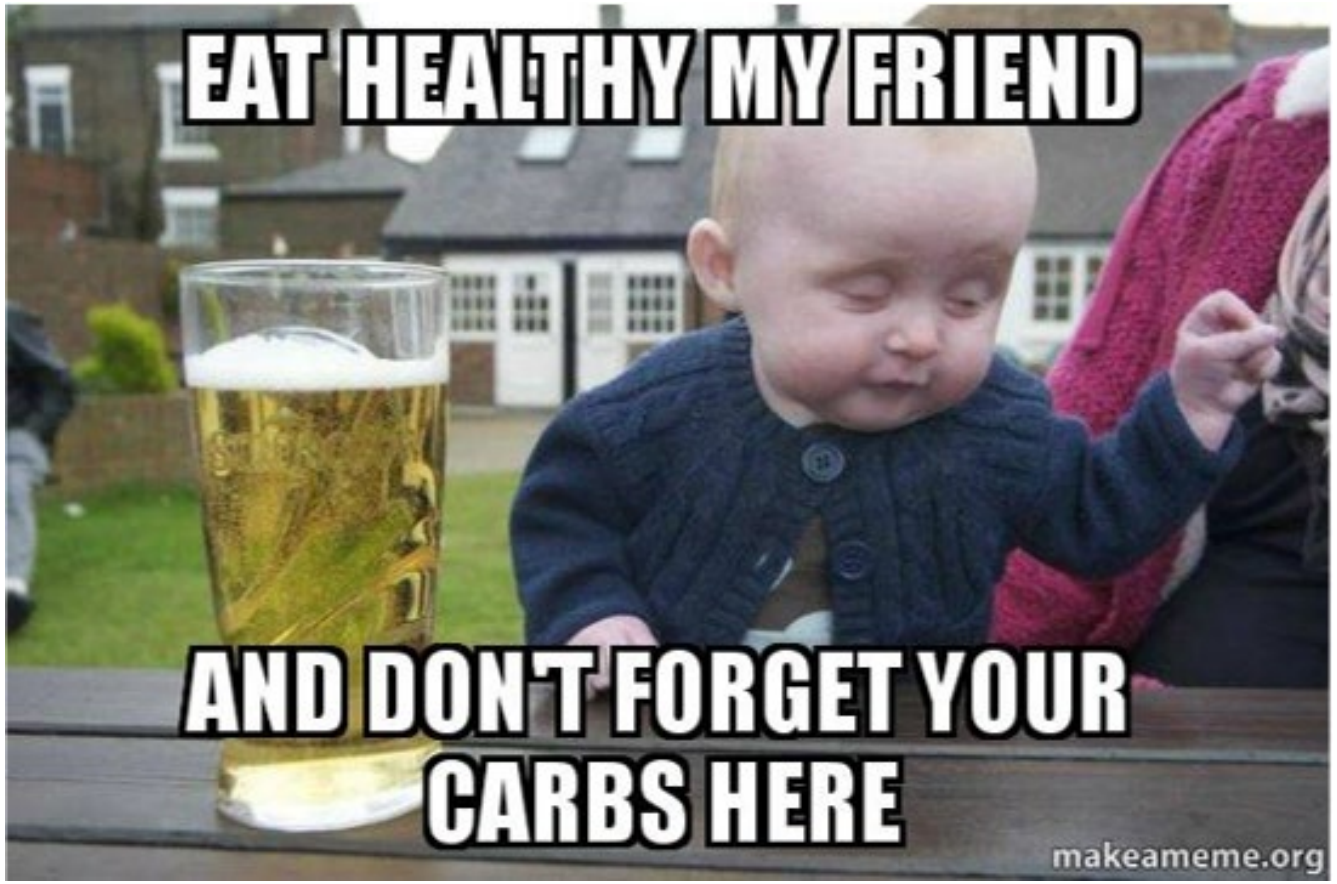
## Enhance carb *and* fat use

- Right fuel at the right time = met flex

## Distress Model (<<10%)

- MmM = Macro MisMatch
- Low liver or muscle glycogen
- Adaptation
- Off season

# *THANK YOU*


EAT HEALTHY MY FRIEND
AND DON'T FORGET YOUR CARBS HERE
makeameme.org

# ADDITIONAL REFERENCES


Krotkiewski M, Lo¨nnroth P, Mandroukas K, Wroblewski Z, Rebuffe´-Scrive M: The effects of physical training on insulin secretion and effectiveness and on glucose metabolism in obesity and type 2 (non-insulin-dependent) diabetes mellitus. Diabetologia 28:881–890, 1985

Ligtenberg PC, Hoekstra JB, Bol E, Zonderland ML, Erkelens DW: Effects of physical training on metabolic control in elderly type 2 diabetes mellitus patients. Clin Sci 93:127–135, 1997

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# *ADDITIONAL REFERENCES*


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Segal KR, Edano A, Abalos A, Albu J, Blando L, Tomas MB, Pi-Sunyer FX: Effect of exercise training on insulin sensitivity and glucose metabolism in lean, obese, and diabetic men. J Appl Physiol 71:2402–2411, 1991

Bogardus C, Ravussin E, Robbins DC, Wolfe RR, Horton ES, Sims EA: Effects of physical training and diet theraphy on carbohydrate metabolism in patients with glucose intolerance and non–insulin-dependent diabetes mellitus. Diabetes 33:311–318, 1984

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Review. PubMed PMID: 11898964.

Bartram C, Edwards RH, Beynon RJ. McArdle's disease-muscle glycogen phosphorylase deficiency. Biochim Biophys Acta. 1995 Aug 15;1272(1):1-13. Review. PubMed PMID: 7662715.