- Fasting is not starvation
- Good news: Hunger pangs go away!
- Less work, less shopping, less cleaning, save money

Intermittent Fasting and Metabolic Health

- **. Introduction**
- Obesity and metabolic syndrome (MetS. i.e., insulin resistance, obesity, HTN, and lipids) are a growing problem all across the globe.
- There has been an increasing focus among the medical community to come up with innovative therapies to counter their pathophysiological effects.
- Intermittent fasting is one such tool that has been proposed repeatedly by health experts due to its benefits on the metabolic syndrome.

Izzah Vasim , Chaudry N. Majeed and Mark D. DeBoer, *Nutrients* **2022**, *14*, 631. https://doi.org/10.3390/nu14030631 https://www.mdpi.com/journal/nutrients *Nutrients* **2022**, *14*, 631

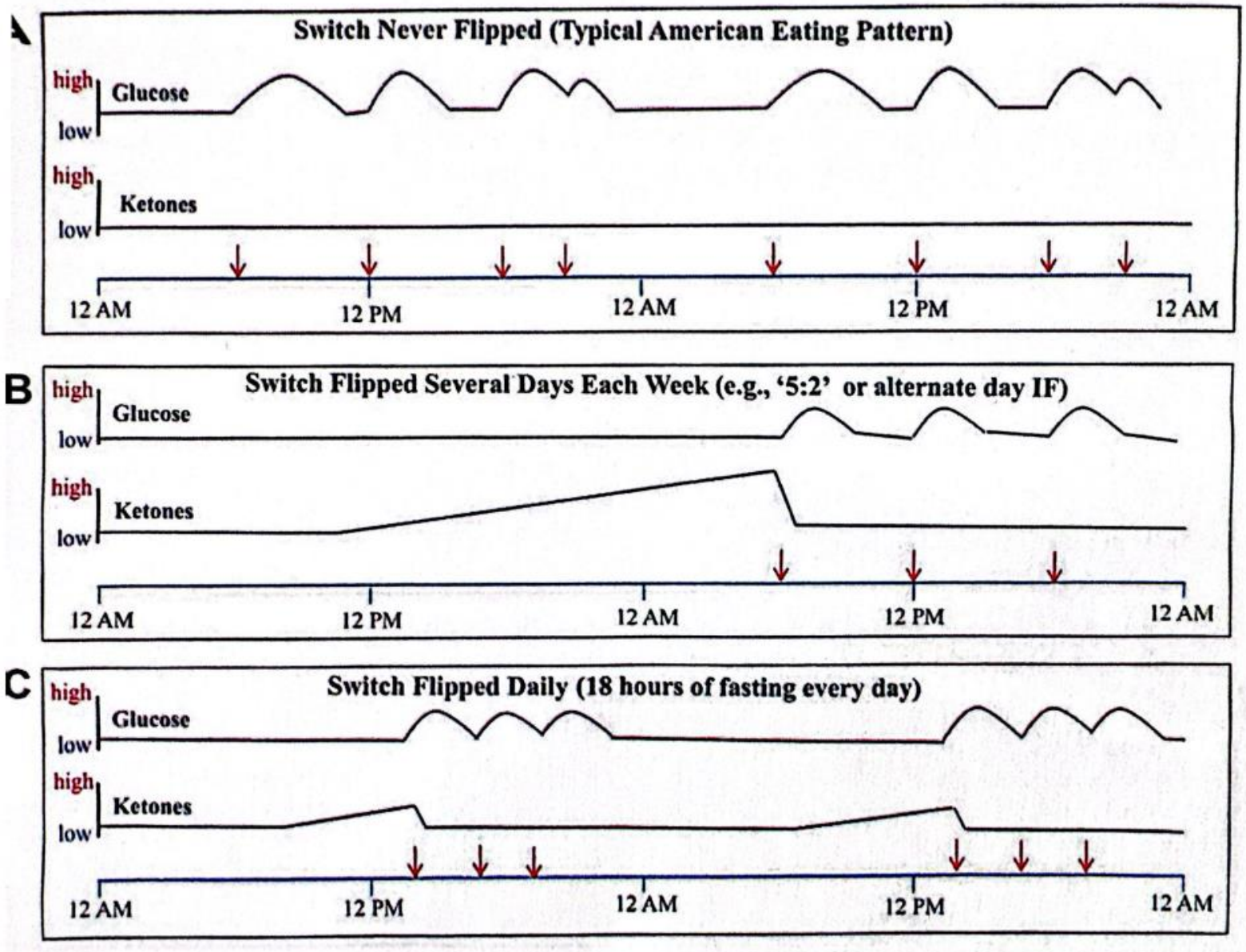
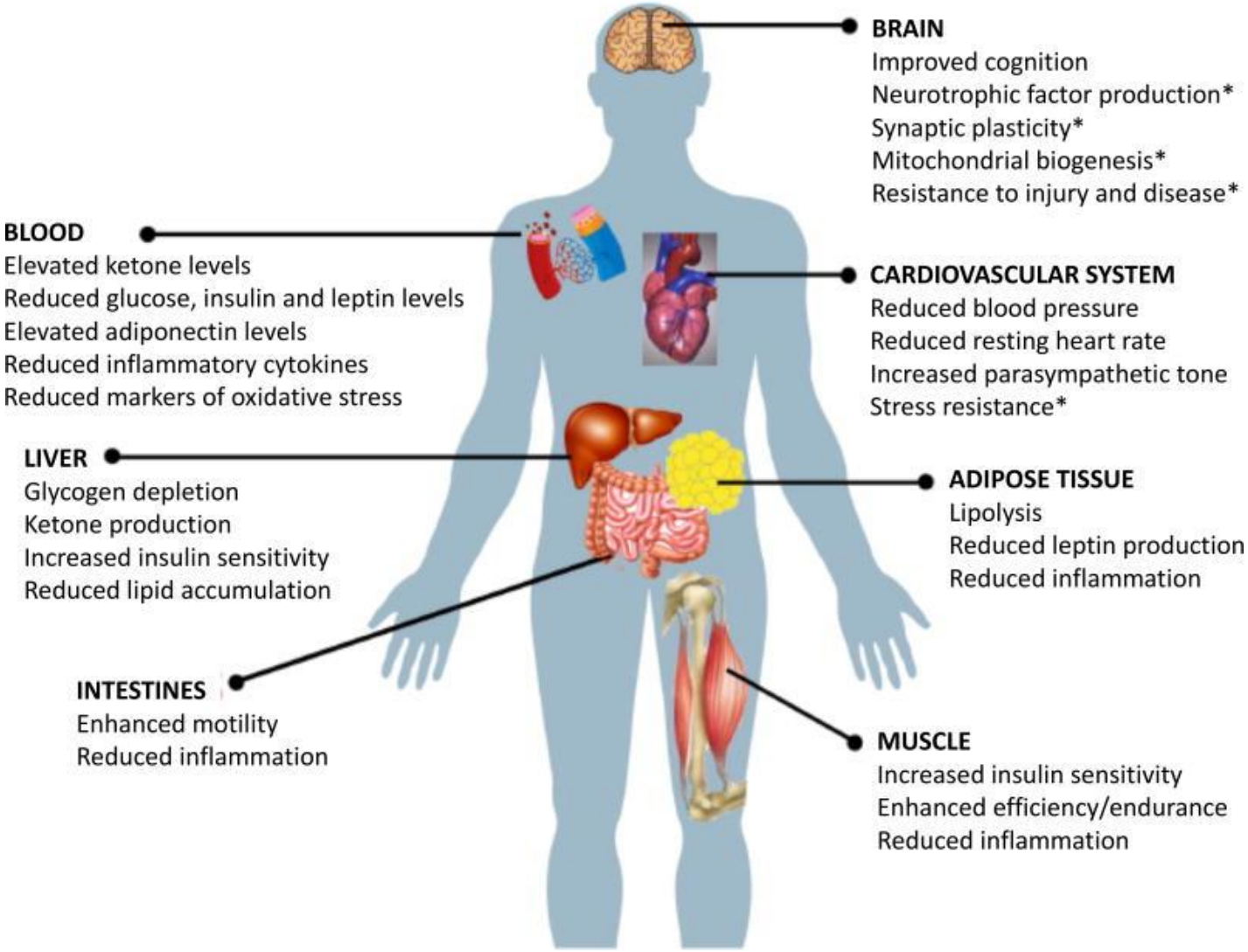


Figure 1. Glucose and ketone levels over the course of three meal eating patterns. (**A**) The standard meal pattern of three meals daily does not result in an appreciable rise in ketone levels. (**B**) The 5:2 or alternate-day fasting pattern allows ketones to rise during prolonged fasting, followed by suppressed ketones during the typical feeding day. (**C**) When meals are compressed to a 6-h period each day, ketones are able to rise during the time between feeding periods. From Anton et al., Obesity 2018:

Examples of functional effects and major cellular and molecular responses of various organ systems to IF.



d for activities of different intensities and durations.

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Activity Intensity	Activity Duration	Preferred Fuel	Oxygen Needed?	Activity Example
Very high	30 sec – 3 min	Glucose	No – anaerobic	Sprinting
High	3 min – 20 min	Glucose	Yes – aerobic	Jogging
Low to moderate	>20 min	Fat	Yes – aerobic	Walking

Alternate Day Fasting and Endurance Exercise Combine to Reduce Body Weight and Favorably Alter Plasma Lipids in Obese Humans

•Surabhi Bhutani, Monica C. Klempel, Cynthia M. Kroeger, John F. Trepanowski and Krista A. Varady

• Obesity (2013) 21, 1370-1379. doi:10.1002/oby.20353

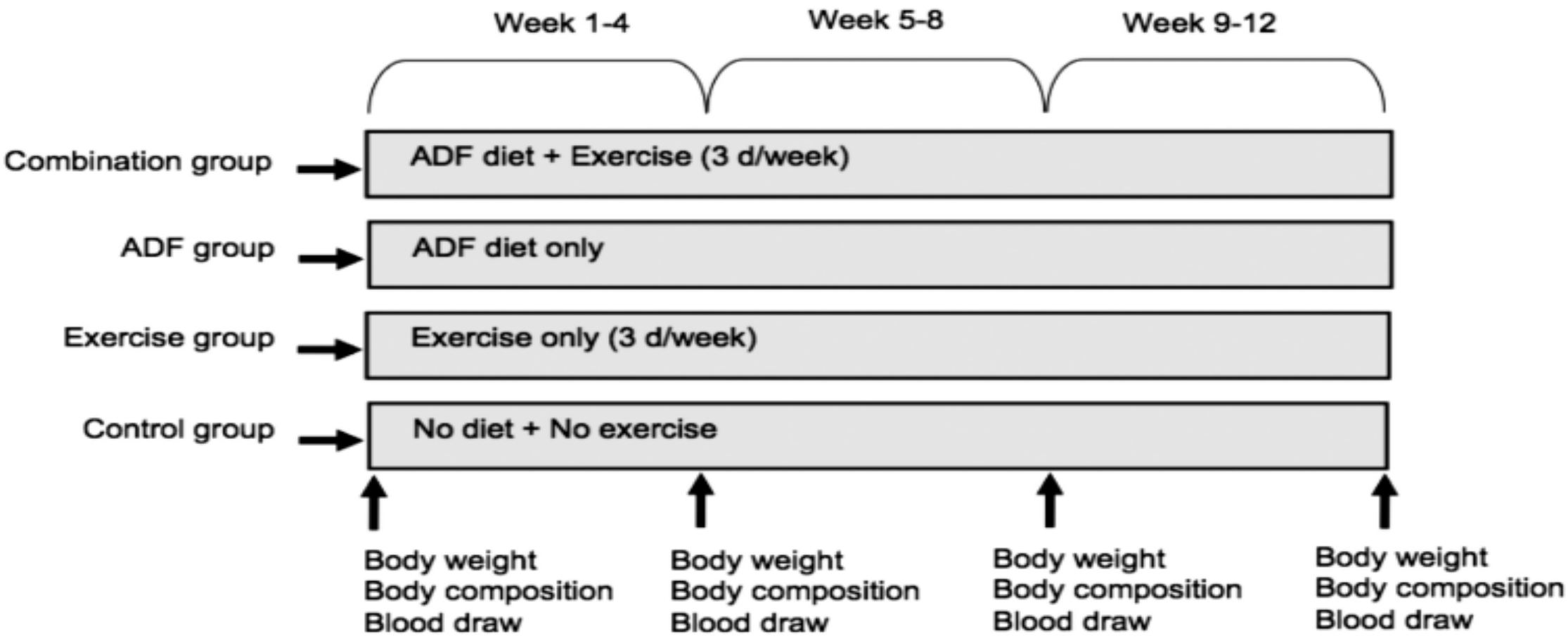


FIGURE 2 Experimental design.

Obesity Alternate Day Fasting and Exercise for Weight Loss Bhutani et al.1372 Obesity | VOLUME 21 | NUMBER 7 | JULY 2013 www.obesityjournal.org

TABLE 3 Body weight and body composition during the 12-week trial

	Intervention	Week 1	Week 12	P-value[a]	P-value[b]	Change[c]	P-value[d]
Body weight (kg)	Combination	91 ± 6	85 ± 6	<0.001	0.393	−6 ± 4[a]	<0.001
	ADF	94 ± 3	91 ± 3	<0.001		−3 ± 1[b]	
	Exercise	93 ± 2	92 ± 2	0.027		−1 ± 0[b]	
	Control	93 ± 5	93 ± 5	0.577		0 ± 0[c]	
Body mass index (kg/m^2)	Combination	35 ± 1	33 ± 1	<0.001	0.334	−2 ± 0[a]	<0.001
	ADF	35 ± 1	34 ± 1	<0.001		−1 ± 0[b]	
	Exercise	35 ± 1	34 ± 1	0.030		−1 ± 0[b]	
	Control	35 ± 1	35 ± 1	0.707		0 ± 0[c]	
Fat mass (kg)	Combination	45 ± 2	40 ± 2	<0.001	0.054	−5 ± 1[a]	<0.001
	ADF	43 ± 2	41 ± 2	0.008		−2 ± 1[b]	
	Exercise	46 ± 2	45 ± 2	0.182		−1 ± 0[b]	
	Control	43 ± 4	43 ± 4	0.570		0 ± 1[b]	
Fat free mass (kg)	Combination	46 ± 2	46 ± 2	0.221	0.299	0 ± 1	0.527
	ADF	51 ± 2	50 ± 2	0.031		−1 ± 1	
	Exercise	48 ± 1	47 ± 1	0.321		−1 ± 0	
	Control	50 ± 2	49 ± 2	0.693		−1 ± 1	
Waist circumference (cm)	Combination	96 ± 2	88 ± 1	<0.001	0.310	−8 ± 1[a]	<0.001
	ADF	100 ± 2	95 ± 2	<0.001		−5 ± 1[b]	
	Exercise	98 ± 2	95 ± 2	<0.001		−3 ± 1[b]	
	Control	98 ± 3	97 ± 2	0.640		−1 ± 1[b]	

Value reported as mean ± SEM. Intention to treat analysis. ADF: Alternate day fasting.
[a]P-value between week 1 and week 12: Repeated-measures ANOVA.
[b]P-value between groups at week 12: One-way ANOVA.
[c]Absolute change between week 1 and week 12 values.
[d]P-value between groups for absolute change: One-way ANOVA. Means not sharing a common superscript letter are significantly different (Tukey post-hoc test).

	Control	97 ± 13	102 ± 11	0.452		7 ± 6 5 ± 7
Systolic BP (mm Hg)[e]	Combination	113 ± 3	111 ± 3	0.262	0.176	−2 ± 2
	ADF	124 ± 3	120 ± 3	0.007		−3 ± 1
	Exercise	113 ± 2	115 ± 3	0.284		2 ± 2
	Control	122 ± 5	120 ± 6	0.603		−2 ± 3
Diastolic BP (mm Hg)[e]	Combination	76 ± 2	76 ± 2	0.939	0.123	0 ± 3
	ADF	82 ± 2	80 ± 2	0.034		−2 ± 2
	Exercise	76 ± 2	76 ± 2	0.976		0 ± 2
	Control	86 ± 2	84 ± 4	0.480		−2 ± 3
Heart rate (bpm)	Combination	78 ± 2	76 ± 2	0.384	0.198	−2 ± 2
	ADF	75 ± 2	75 ± 2	0.711		0 ± 1
	Exercise	71 ± 2	71 ± 2	0.925		0 ± 2
	Control	76 ± 3	77 ± 3	0.763		1 ± 5
Fasting glucose (mg/dl)	Combination	94 ± 2	92 ± 3 [a]	0.589	0.021	−2 ± 4
	ADF	98 ± 5	95 ± 5 [a]	0.146		−3 ± 2
	Exercise	92 ± 2	91 ± 2 [a,b]	0.862		−1 ± 2
	Control	109 ± 7	111 ± 6 [b]	0.637		2 ± 4
Fasting insulin (μIU/ml)	Combination	14 ± 2	11 ± 2	0.305	0.436	−21 ± 15
	ADF	23 ± 8	21 ± 8	0.050		−7 ± 6
	Exercise	11 ± 1	11 ± 1	0.666		0 ± 8
	Control	25 ± 4	21 ± 4	0.178		−16 ± 9
HOMA-IR	Combination	3 ± 1	3 ± 0	0.296	0.396	0 ± 17
	ADF	7 ± 3	7 ± 3	0.092		0 ± 7
	Exercise	3 ± 0	3 ± 0	0.782		0 ± 10
	Control	7 ± 2	7 ± 2	0.165		0 ± 11
C-reactive protein (mg/dl)	Combination	0.5 ± 0.2	0.5 ± 0.2	0.488	0.943	0 ± 28
	ADF	0.5 ± 0.1	0.5 ± 0.1	0.344		0 ± 12

TABLE 5 LDL particle size during the 12-week trial

	Intervention	Week 1	Week 12	P-value[a]	P-value[b]	Change[c]	P-value[d]
LDL particle size (Å)	Combination	260 ± 1	264 ± 2 [a]	<0.001	0.031	4 ± 1 [a]	0.010
	ADF	261 ± 1	266 ± 1 [a]	<0.001		5 ± 1 [a]	
	Exercise	261 ± 2	262 ± 2 [b]	0.426		1 ± 1 [b]	
	Control	259 ± 1	260 ± 2 [b]	0.884		0 ± 1 [b]	
Large LDL particles (%)	Combination	38 ± 4	45 ± 5 [a]	0.142	0.014	7 ± 5	0.064
	ADF	36 ± 3	51 ± 4[a]	<0.001		15 ± 3	
	Exercise	39 ± 3	40 ± 4[b]	0.792		1 ± 5	
	Control	30 ± 3	31 ± 4[b]	0.883		1 ± 4	
Medium LDL particles (%)	Combination	37 ± 2	38 ± 2	0.845	0.301	1 ± 3	0.817
	ADF	37 ± 1	35 ± 1	0.288		−2 ± 2	
	Exercise	41 ± 3	40 ± 3	0.453		−1 ± 2	
	Control	41 ± 2	40 ± 2	0.717		−1 ± 2	
Small LDL particles (%)	Combination	25 ± 3	18 ± 3[a]	0.010		−7 ± 2[a]	0.007
	ADF	27 ± 3	15 ± 3[a]	<0.001	0.023	−12 ± 3[a]	
	Exercise	21 ± 3	20 ± 4[b]	0.972		−1 ± 4[b]	
	Control	29 ± 3	30 ± 3[b]	0.776		1 ± 3[b]	

Value reported as mean ± SEM. Intention to treat analysis. ADF: Alternate day fasting. Large LDL particles (>260 Å), medium LDL particles (255-260 Å), and small LDL particles (<255 Å).
[a]P-value between week 1 and week 12: Repeated-measures ANOVA.
[b]P-value between groups at week 12: One-way ANOVA. Means not sharing a common superscript letter are significantly different (Tukey post-hoc test).
[c]Absolute change between week 1 and week 12 values.
[d]P-value between groups for absolute change: One-way ANOVA. Means not sharing a common superscript letter are significantly different (Tukey post-hoc test).

HEART online

Rating of Perceived Exertion (RPE) Category Scale

6

7 Very, very light

8

9 Very light

10

11 Fairly light

12

13 Somewhat hard

14

15 Hard

16

17 Very hard

18

19 Very, very hard

20

Borg G. Borg's Perceived Exertion and Pan Scales. Champaign, IL: Human Kinetics, 1998.

Rating of perceived exertion: Borg scales continued...

HEART online

Rating of Perceived Exertion (RPE) Category-Ratio Scale

0 Nothing at all

0.3

0.5 Extremely weak Just noticeable

0. 7

1 Very weak

1.5

2 Weak Light

2. 5

3 Moderate

4

5 Strong Heavy

6

7 Very strong

8

9

10 Extremely strong "Maximal"

11

• Absolute maximum Highest Possible

Borg G. Borg's Perceived Exertion and Pan Scales. Champaign, IL: Human Kinetics, 1998

How can we incorporate it safely?

- Should be alright for most patients
- Start cautiously
- Listen to your body
- Caution for Type 2 diabetic taking diabetic medications including insulin, GLP 1 analogues, etc.
- Contraindicated in Type 1 diabetics and pregnant women

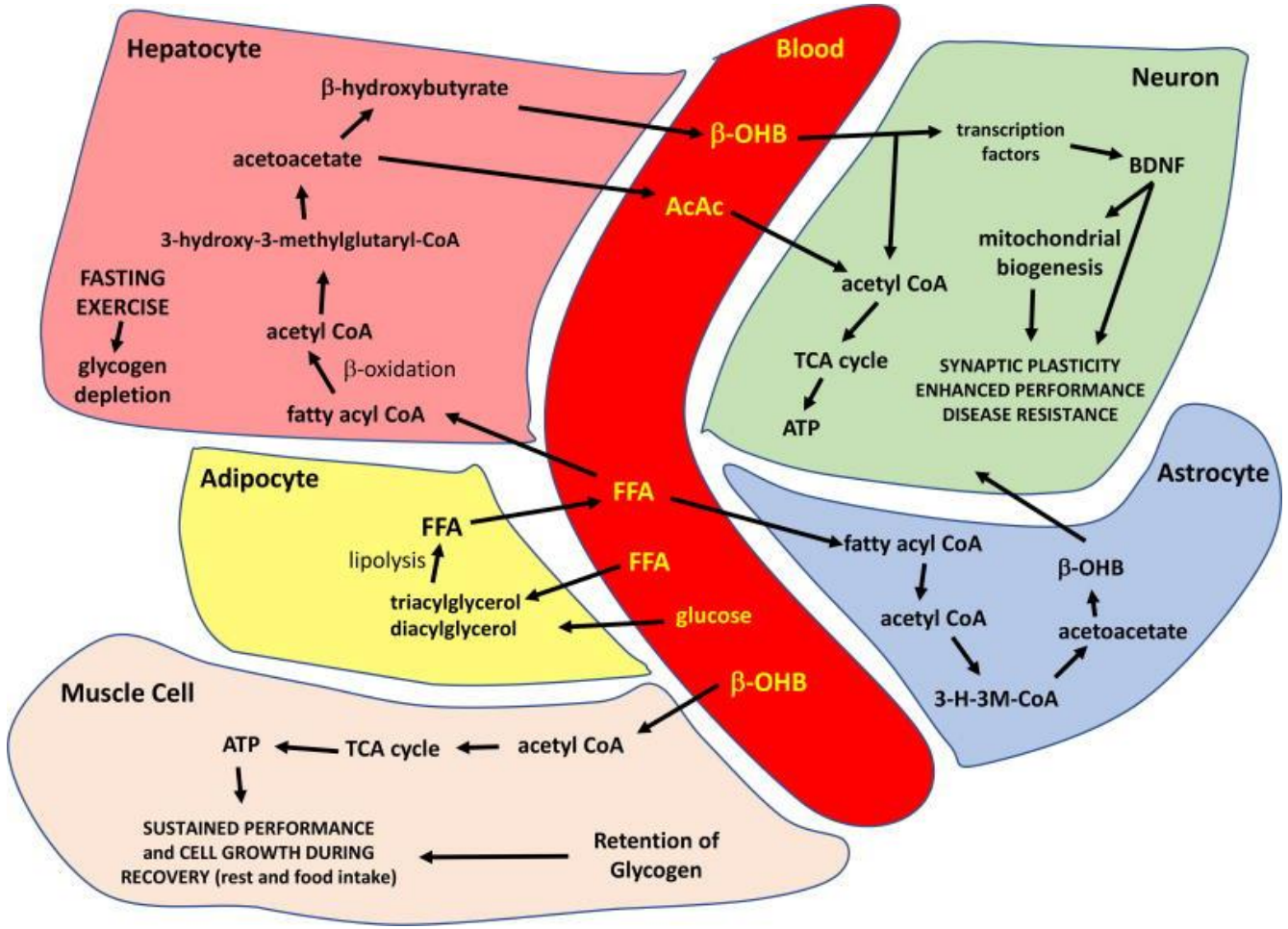
Summary of the major metabolic pathways involved in the metabolic switch and responses of excitable cells to the ketone β-hydroxybutyrate (β-OHB). See text for description. AcAc, acetoacetate; ATP, adenosine tr

Obesity (Silver Spring). 2018 Feb; 26(2): 254–268.
Published online 2017 Oct 31. doi: 10.1002/oby.22065
PMCID: PMC5783752
NIHMSID: NIHMS912771
PMID: 29086496

Flipping the Metabolic Switch: Understanding and Applying Health Benefits of Fasting

Stephen D. Anton,[1] Keelin Moehl,[2] William T. Donahoo,[3] Krisztina Marosi,[2] Stephanie Lee,[1] Arch G. Mainous, III,[4] Christiaan Leeuwenburgh,[1] and Mark P. Mattson[2,5]

iphosphate; FFA, free fatty acids; TCA, tricarboxylic acid.



10.3 Fuel Sources for Exercise – Introduction to Nutrition and Wellness (pressbooks.pub)

Figure 10.1. Anaerobic vs aerobic metabolism. Note that carbohydrate is the only fuel utilized in anaerobic metabolism, but all three macronutrients can be used for fuel during aerobic metabolism.