

IOWA

Department of Family and
Community Medicine

Flexibility, More than Muscles!

Scott M. Eberly, MD CMD

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Frontmatter

- Practicing internist for 26 years.
- Current focus is nursing home work serving 8 local nursing homes as an assistant professor in the Department of Family and Community Medicine.
- I have no financial disclosures regarding any of the information presented today.
- Medical information will be presented today but not medical advice. Please see your personal provider for personal recommendations.

Objectives

- Understand the importance of flexibility in human function.
- Identify specific areas of emphasis for efforts toward flexibility.
- Understand potential benefits toward achieving this flexibility.

Ocham's Razor

- William of Ockham (c. 1287–1347), an English Franciscan friar and scholastic philosopher, is credited with the principle.
- The Latin phrase commonly associated with Ockham's razor is

"Entia non sunt multiplicanda praeter necessitatem," meaning "entities should not be multiplied beyond necessity"



Hickam's dictum

- John Bamber Hickam, MD (c. 1914-1970), Chair of Medicine Indiana University 1958-1970.
- This counter-principle states, "Patients can have as many diseases as they damn well please," emphasizing the need to consider multiple diagnoses when clinically appropriate.



The Problem: The Disability Gap

- Average healthy adjusted life expectancy: 66 years.
- Average life span. 80 years.
- Disability Gap. 14 years on average.

Who lives in a nursing home?

- Dementia and Stroke 46%
- Heart failure
- Parkinson's disease
- Osteoarthritis
- Diabetes mellitus
 - Increase from 4.3 to 11.4% over 1993-2005.

Bimodal Nature of Human physiology and experience.

Phase I

1. Sleep
2. Feeding
3. Exercise
4. Community

Phase II

1. Awake
2. Fasting
3. Rest
4. Isolation

Flexibility

- Ability to move fluidly from one state to another fully participating in each state.
- The opposite of flexibility is inflexibility resulting in chronic stress of the chronically adopted state.
- Acute stress is beneficial.
- Chronic stress wears down the system.

Sleep and Wake Cycle



Healthy Sleep Guidelines...and reality.

- Average sleep duration for average adult is 7-9 hours per night.
- American Academy of Sleep Medicine and the Sleep Research Society recommend adults aged 18-60 obtain 7 or more hours of sleep per night.
- The National Sleep Foundation also recommends 7-8 hours for adults > 65 years old.
- 28-37% of adults report sleeping less than 7 hours per night. Morb Mortal Wkly Rep. 2022 Mar 11;71(10):393.

Implications of disordered sleep.

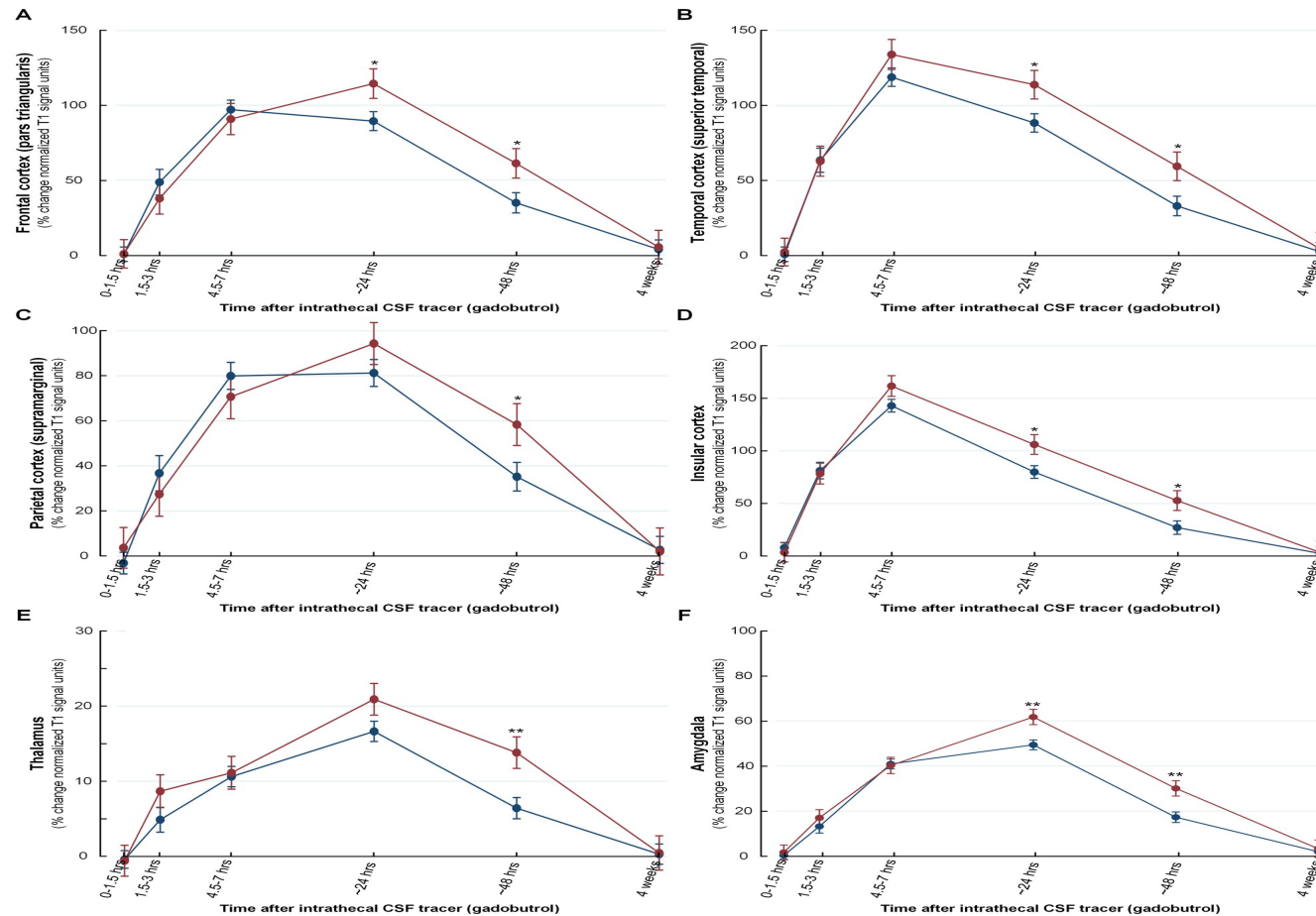
Too Much (> 9 hours / night)

1. Increase risk of metabolic syndrome and obesity.
2. Increase risk of cardiovascular disease
3. Increase depression and cognitive impairment.
4. Higher risk of all cause mortality.

Too Little (< 7 hours / night)

1. Increase risk of hypertension, coronary artery disease and stroke.
2. Increased risk of obesity and metabolic syndrome.
3. Increased risk of depression, anxiety, and cognitive impairment.
4. Immune dysfunction
5. Higher all risk mortality.

Per Kristian Eide, Vegard Vinje, Are Hugo Pripp, Kent-Andre Mardal, Geir Ringstad, **Sleep deprivation impairs molecular clearance from the human brain**, *Brain*, Volume 144, Issue 3, March 2021, Pages 863–874.



Good Sleep Hygiene

- Consistent sleep schedule
- Cool, dark, quiet bedroom reserved for sleep and intimate activities only.
- Avoid caffeine, nicotine and alcohol in the evening.
- Limit screen time use before bed.
- Regular daytime exercise
- Light exposure during the day.
- If unable to sleep get up for a quiet activity and return to bed when drowsy maintaining sleep schedule.

Feeding Fasting Cycle



Healthy metabolic parameters

- BMI 18.5-25
- Fat percentage for men 13-24%
- Fat percentage for women 20-33%
- Hgb a1c < 5.7 for adults
- Fasting glucose < 100
- Triglycerides to HDL ratio < 2

Metabolic syndrome

Component	NCEP ATP III	IDF	WHO
Central obesity	Waist circumference ≥ 40 in (men), ≥ 35 in (women)	Waist circumference ≥ 37 in (men), ≥ 32 in (women) (ethnic-specific)	Waist-to-hip ratio > 0.90 (men), > 0.85 (women) or BMI $> 30 \text{ kg/m}^2$
Triglycerides	$\geq 150 \text{ mg/dL}$	$\geq 150 \text{ mg/dL}$	$\geq 150 \text{ mg/dL}$
HDL cholesterol	$< 40 \text{ mg/dL}$ (men), $< 50 \text{ mg/dL}$ (women)	$< 40 \text{ mg/dL}$ (men), $< 50 \text{ mg/dL}$ (women)	$< 35 \text{ mg/dL}$ (men), $< 39 \text{ mg/dL}$ (women)
Blood pressure	$\geq 130/85 \text{ mmHg}$	$\geq 130/85 \text{ mmHg}$	$\geq 140/90 \text{ mmHg}$
Fasting glucose	$\geq 100 \text{ mg/dL}$	$\geq 100 \text{ mg/dL}$	$\geq 110 \text{ mg/dL}$ or insulin resistance

Prevalence of Metabolic Syndrome

Age group	Prevalence (%)
<40 years	17.5
40–49 years	29.7
50–59 years	37.5
60–69 years	44.4
≥70 years	47.0

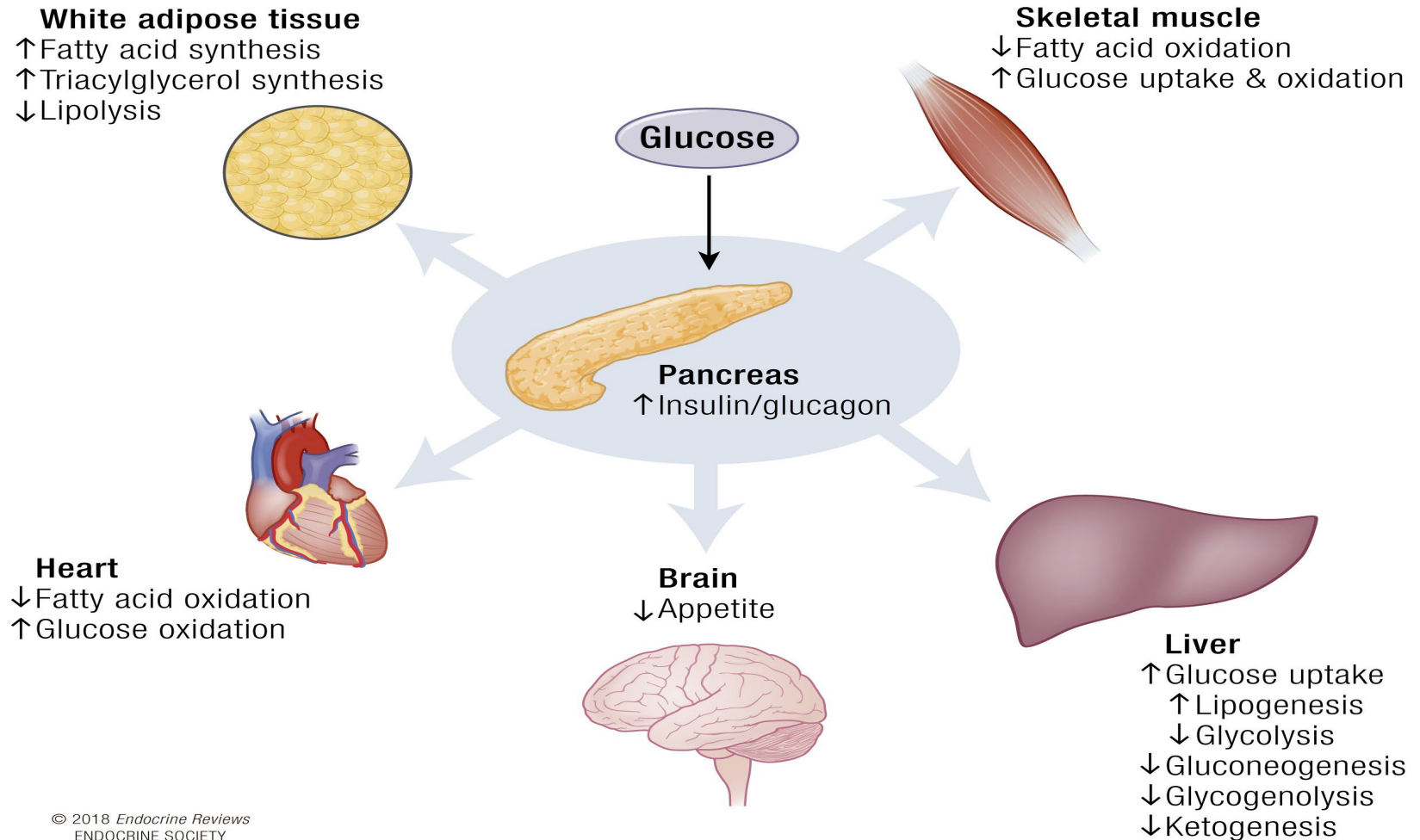
Morbidity of Metabolic Syndrome

- **Stroke**: 1.5 – 2.3 fold increased risk of stroke.
- **Cardiovascular disease**: 1.5 – 2 fold increase in risk of coronary artery disease, heart failure, sudden death.
- **Diabetic complications**: 2-3 fold higher risk of CKD and 1.5 – fold higher risk of severe diabetic retinopathy and neuropathy.
- **Dementia risk**: Mostly vascular dementia at similar rates to above between 1 and 2.5 fold increase.

Hormonal regulation of satiety

Hormone	Source	Macronutrient response	Satiety effect
GLP-1	L-cells	Protein > carbohydrate > fat	High
PYY	L-cells	Protein > carbohydrate > fat	High
Ghrelin	Stomach	Protein > carbohydrate > fat (suppression)	High
Insulin	Pancreas	Carbohydrate > protein > fat	Moderate
Amylin	Pancreas	Carbohydrate > protein > fat	Moderate
CCK	I-cells	Protein > fat > carbohydrate	Moderate

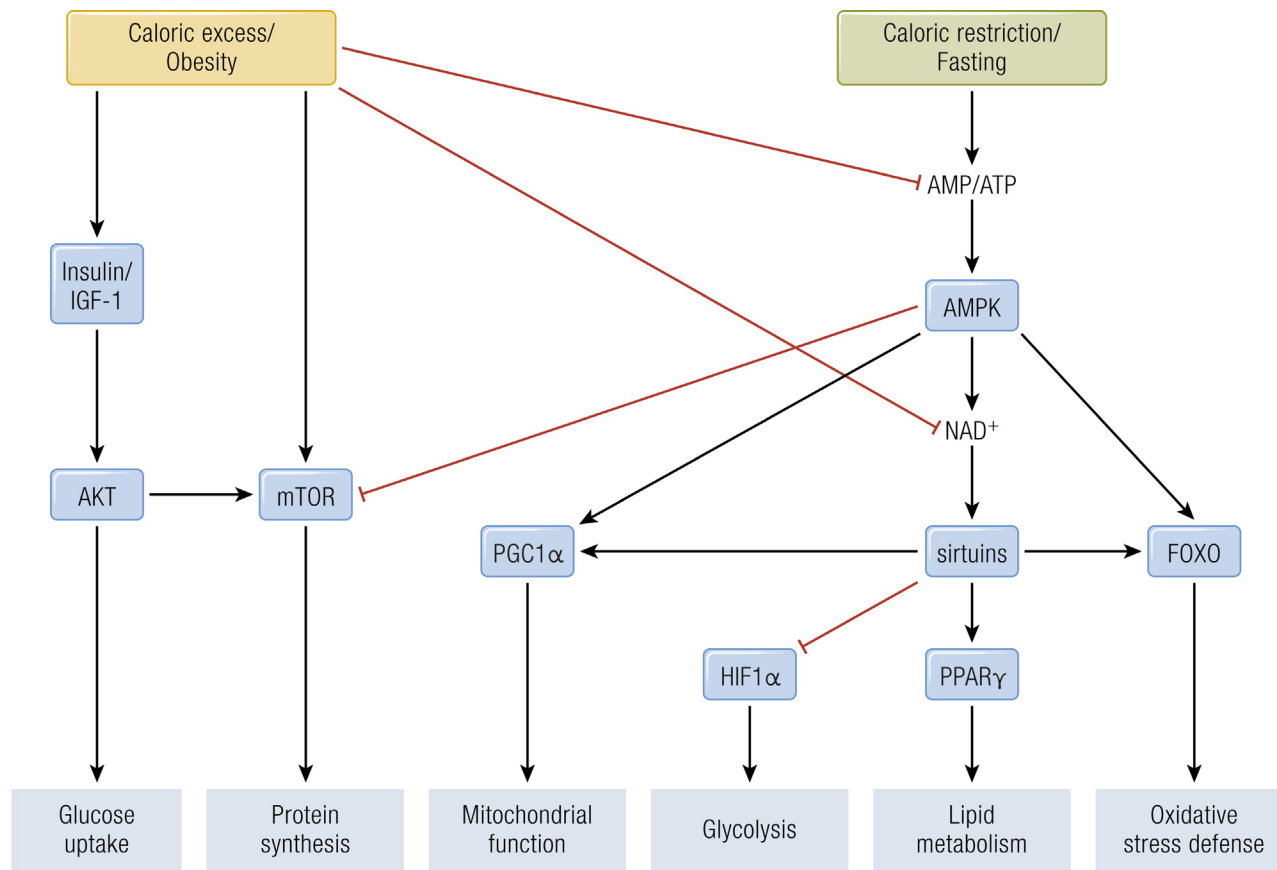
Fed Hormonal State



Fasting and Fed Hormonal State

HORMONE	FASTING STATE	FED STATE
Insulin	Low; suppresses hepatic glucose output; promotes lipolysis and ketogenesis	High; promotes glucose uptake, glycogen synthesis, lipogenesis; suppresses lipolysis <u>1</u>
Glucagon	High; stimulates glycogenolysis, gluconeogenesis, ketogenesis	Low; suppressed by insulin and incretins <u>1</u>
Ghrelin	High; stimulates appetite and GH secretion	Low; suppressed by nutrient intake <u>3</u>
Leptin	Low; increases appetite, reduces energy expenditure	High; suppresses appetite, increases energy expenditure <u>2</u>
Cortisol	Elevated; promotes gluconeogenesis, proteolysis, lipolysis	Lower; reduced catabolic activity <u>1</u>
Growth hormone	Elevated; promotes lipolysis, reduces insulin sensitivity	Lower; reduced lipolysis, increased insulin sensitivity <u>1</u>
Catecholamines	Elevated; stimulate glycogenolysis, lipolysis	Lower; reduced sympathetic activity <u>1</u>
GLP-1	Low; minimal insulinotropic effect	High; enhances insulin secretion, suppresses glucagon, slows gastric emptying <u>1</u>
GIP	Low; minimal insulinotropic effect	High; enhances insulin secretion <u>1</u>
FGF21	Elevated; promotes fatty acid oxidation, ketogenesis	Lower; reduced lipid oxidation <u>1</u>

Biochemical activity of Feeding and Fasting



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Fasting vs. Starvation Hormone Makeup

Hormone	Fasting (12–48 h)	Starvation (>48 h)
Insulin	↓ (low-normal)	↓↓ (very low)
Glucagon	↑ (moderate)	↑↑ (high)
Cortisol	↔/↑ (mild)	↑↑ (high)
Growth hormone	↑ (pulsatile)	↑↑ (high)
Catecholamines	↑ (mild)	↑↑ (high)
Thyroid hormones	↔/↓ (mild)	↓↓ (low T3, low T4, high rT3)
Leptin	↓ (moderate)	↓↓ (very low)
Ghrelin	↑ (transient)	↓ (suppressed)
Reproductive hormones	↔/↓ (mild)	↓↓ (hypogonadism)
ADH	↔/↑ (mild)	↑↑ (high)

Quick Math Problem: How much excess energy do I have stored?

1. Calculate lbs. of current fat

Current weight x measured fat percentage = current amount of fat

210 lbs x 27% fat = 56.7 lbs of fat

2. Calculate lbs. of ideal fat.

Ideal weight x Ideal fat percentage = ideal amount of fat

180 lbs x 22% fat = 39.6 lbs of fat

3. Calculate energy excess.

17.1 lbs of excess fat

3500 calories per pound of fat

59,850 excess calories

119 days of a 500 calorie deficit

Or could sustain a 30 day fast?

Conclusion

1. Most have significant excess energy.
2. We need to allow fasting hormones to work

Time Restricted Eating

- Consult your physician to consider significant changes.
- Most people will consider one meal per day or two meals per day in a 6–8-hour window.
- Depending on your metabolic flexibility it may take a few weeks to start burning fat. If you are unable to burn fat, initially you will feel poorly during the fasting phase. This will improve over time.
- Once in the fasting state you will make ketones as you metabolize fat instead of glucose.
- Watch for undereating.

Composition of a Ketogenic diet

Macronutrient	Percentage of total energy intake	Absolute intake (typical range)
Fat	70–80%	150–200 g/day
Protein	10–20%	60–100 g/day
Carbohydrate	<10%	20–50 g/day

How do you measure ketones?

Method	Ketone body measured	Accuracy	Invasiveness	Clinical utility	Limitations
Blood ketone meters	β -hydroxybutyrate	High	Invasive	DKA diagnosis and monitoring	Finger-prick, cost
Urine dipsticks	Acetoacetate	Moderate	Non-invasive	Screening, dietary monitoring	Delayed, false results
Breath analyzers	Acetone	Moderate	Non-invasive	Screening, dietary monitoring	Variability, limited validation
Laboratory assays	β -hydroxybutyrate	High	Invasive	Precise quantification	Cost, availability
CKM	β -hydroxybutyrate	Emerging	Minimally invasive	Real-time monitoring	Limited availability

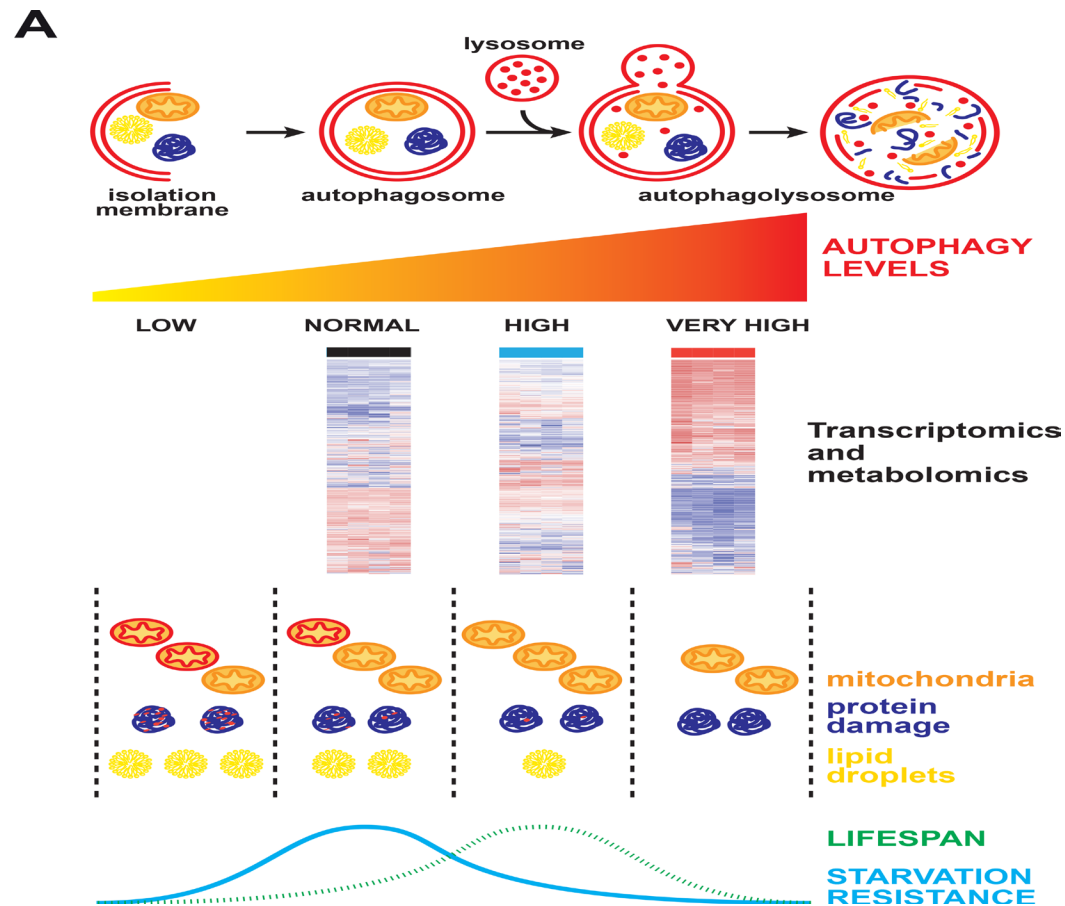
Difference between physiologic ketosis and diabetic ketoacidosis.

Physiological condition	β -Hydroxybutyrate concentration in plasma (range in mmol/l)
Normal circadian variation	0.1–0.4
After prolonged exercise	0.3–2
After 1–2 days of fasting	1–2
After 2–3 weeks of fasting	5–7
After 1–3 weeks of ketogenic diet	0.5–5
During diabetic ketoacidosis	3–25

Autophagy and GKI

- Definition: Autophagy is a lysosome-dependent intracellular degradative pathway that recycles cytoplasmic components to maintain homeostasis and support survival during nutrient or energy stress.
- The glucose–ketone index (GKI) is a clinical metric defined as the ratio of blood glucose (mmol/L) to blood ketones (mmol/L), reflecting the balance between glycolysis and ketolysis; a lower GKI indicates greater reliance on ketone metabolism and is associated with enhanced autophagy

Role of Autophagy



Benefits of Time restricted eating and fasting.

- Improved insulin sensitivity and glucose levels.
- Supports weight loss
- Reverses Metabolic Syndrome
- Improved mental clarity.
- Improved mitochondrial function
- Autophagy
- More time in the day

Exercise Rest Cycle



Optimal Exercise Guidelines

Activity type	Recommendation
Moderate-intensity aerobic	150–300 minutes per week
Vigorous-intensity aerobic	75–150 minutes per week
Muscle-strengthening	≥2 days per week
Sedentary behavior	Limit sedentary time; replace with activity
Older adults (≥65 years)	Multicomponent activity ≥3 days per week

Hormonal effect of low intensity exercise.

- Reduced baseline cortisol: Reflects lower chronic stress and improved HPA axis regulation.
- Improved insulin sensitivity: Sustained glycemic control and metabolic health.
- Modest anabolic support: Small increases in testosterone, GH, and IGF-1 aid muscle maintenance and recovery.
- Enhanced immune function: Lower chronic inflammation and better immune regulation.

Health Benefits of Exercise

- **Reduced Risk:** Cardiovascular disease, Type 2 Diabetes Mellitus, Certain Cancers, All cause mortality.
- **Improved Health:** Mental health, cognitive function, quality of life.
- **Enhanced performance:** Improved physical performance, balance, reduced risk of falls.

Community vs. Isolation



Optimal Community

- **Circles of Support**
 - **Circle of Intimacy (3- 5 people)**
 - **Circle of Friendship – social activities but not intimate details.**
 - **Circle of Participation- connected by location, work, spiritual community, gyms but do not get together in other locations.**
 - **Circle of Exchange- transactional relationships. Checker at the grocery store, doctor, accountant.**
- It takes on average 200 hours, or two-hour coffee dates twice a week for a year to develop a close friendship.

Components of Healthy Relationship

- Unconditional Love
- Mutual Support
- Loyalty and Respect
- Growth
- Encouragement and Accountability

Cycles of Healthy Relationship

- Togetherness
- Trial
- Apology and Acceptance or Repentance and Forgiveness
- Reconciliation
- Deeper togetherness

Health Benefits of an Intact Social Network

Pathway	Positive effects of friendship and community	Negative effects of isolation and loneliness
Neuroendocrine	- Reduced cortisol - Increased oxytocin - Balanced testosterone	- Elevated cortisol - Reduced oxytocin - Hormonal imbalance
Inflammatory	- Lower IL-6, CRP, TNF-α - Improved immune function	- Increased inflammation - Immune dysregulation
Behavioral	- Increased physical activity - Healthy diet - Better sleep	- Sedentary behavior - Poor diet - Sleep disturbances
Clinical outcomes	- Lower insulin resistance - Reduced metabolic syndrome - Lower type 2 diabetes risk	- Increased insulin resistance - Higher metabolic syndrome - Increased type 2 diabetes risk

Summary

1. Our bodies and minds are made for cycles of life. Look for the rhythms of stress and recovery.
2. Acute stress builds.
3. Chronic stress destroys.
4. Stay flexible and take as many as possible along for the ride.

TRAIL of Johnson County and Athletico Physical Therapy

Thank you!

Scott Eberly, MD CMD
Assistant Clinical Professor
Department of Family and
Community Medicine

scott-eberly@uiowa.edu

Questions?

Scott Eberly, MD CMD
Assistant Clinical Professor
Department of Family and
Community Medicine

scott-eberly@uiowa.edu

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