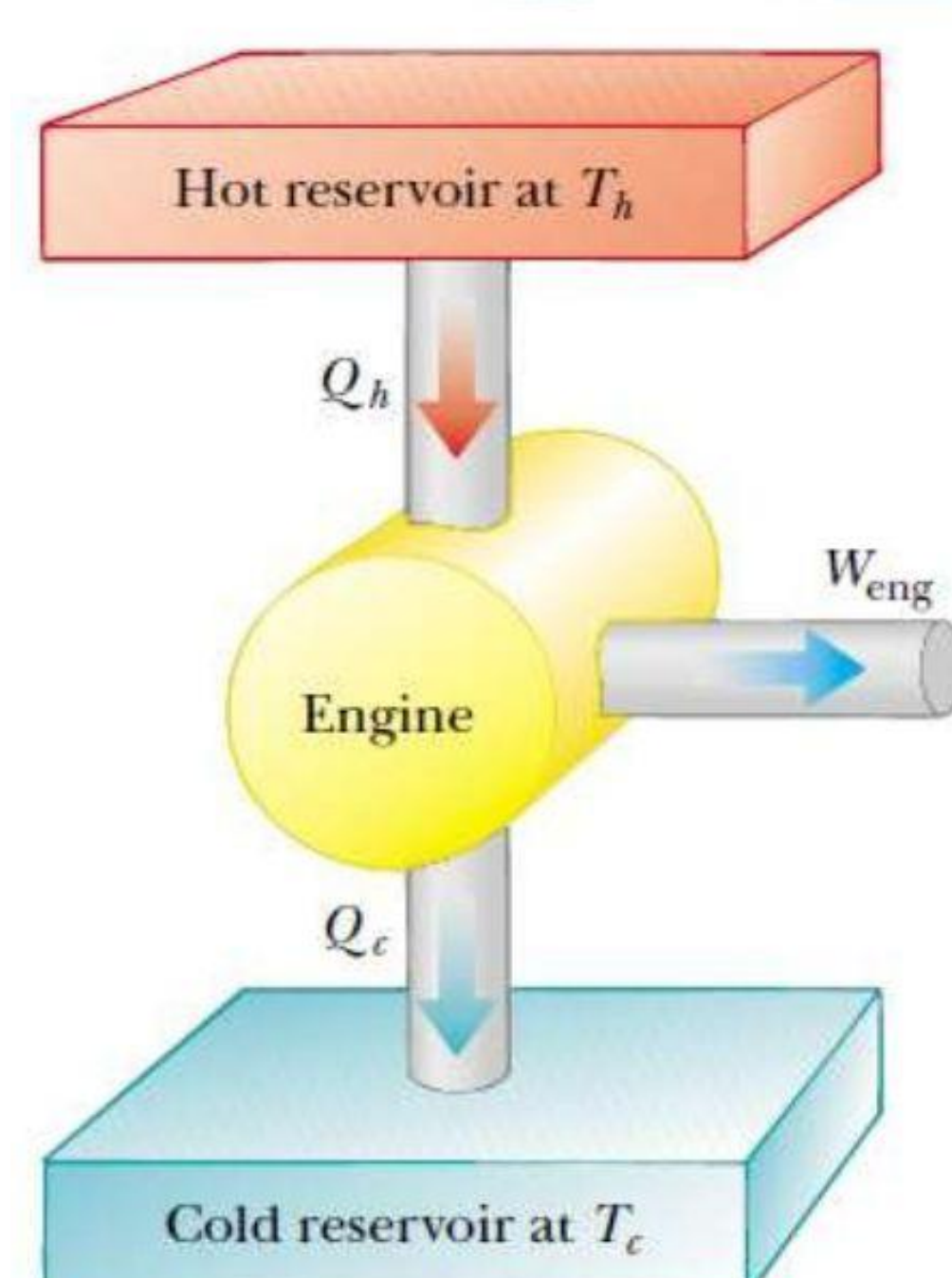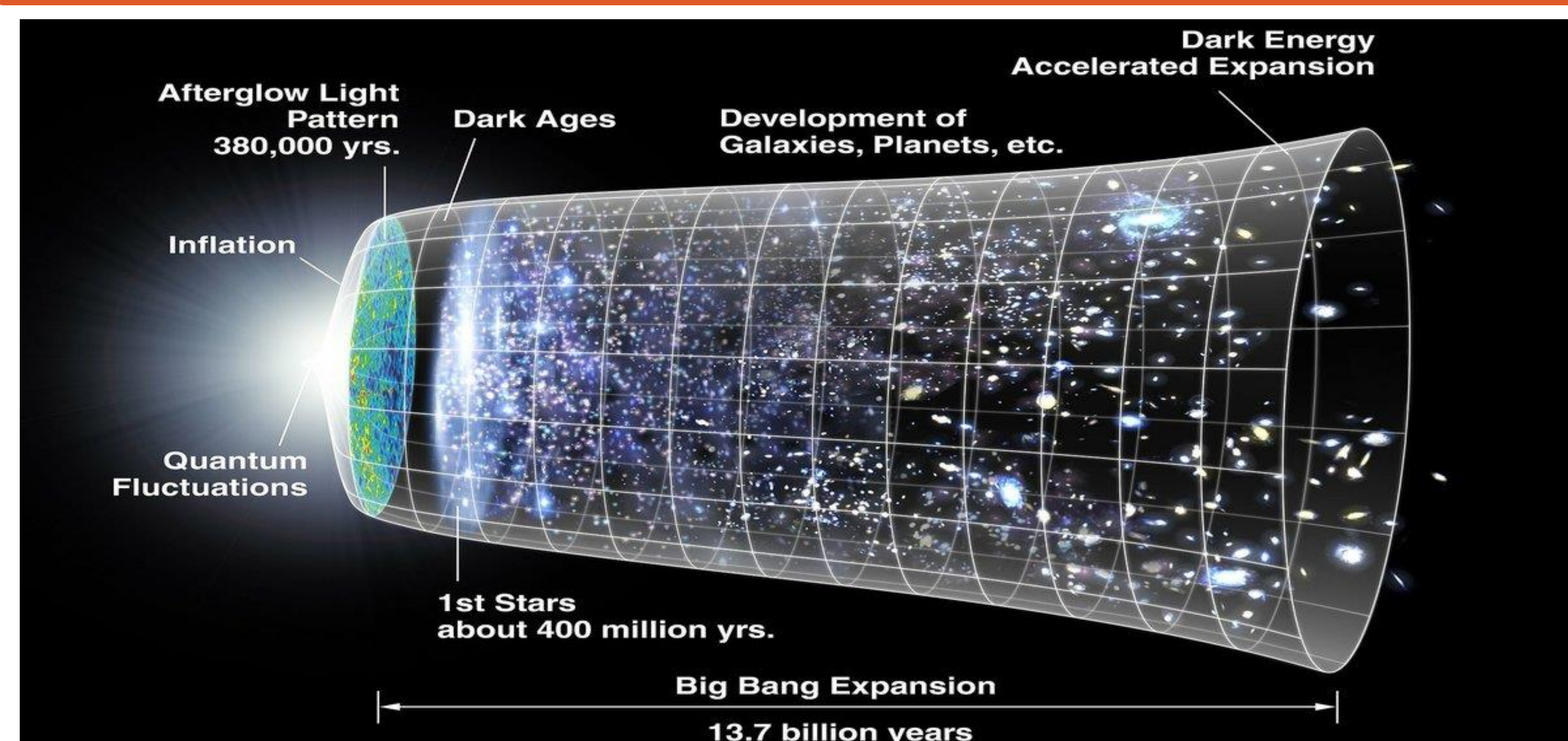# The Human Heat Engine: Validating a Weight Loss Predictive Model

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Background - How is the Model Created?

Entropy is the tendency of Energy to Spread out over time

What is a Heat Engine?

Energy will always spread from high concentration to low concentration

A Heat Engine captures some of this spreading energy for usable work

A Human Heat Engine – Forward & Reverse

Terms

Metabolism – The sum Energy of all chemical reactions in food and storage breakdown

Safety and Reciprocity Quotient (SRQ) - The ratio between Energy spent on Autonomic Function and energy stored in tissue (Glycogen, Adipose, Muscle)

Objective

Validate a model which shows different trends in weight loss, while **calorie deficit is held constant**, by altering stress and Glycemic Index of Diet

Methods

Computational Model
- Developed a thermodynamic-based model of human energy utilization
- Grounded in the 1st and 2nd laws of thermodynamics and established biochemical pathways

Energy Utilization Hierarchy
- **Metabolic Fuel Source Order**
  1. Dietary energy
  2. Stored carbohydrates
  3. Adipose tissue
  4. Muscle protein
- **Work Allocation**
  1. Vitals
  2. Somatic Activity (Exercise)
  3. Remaining energy divided between:
     - Autonomic Functions: Tissue Storage
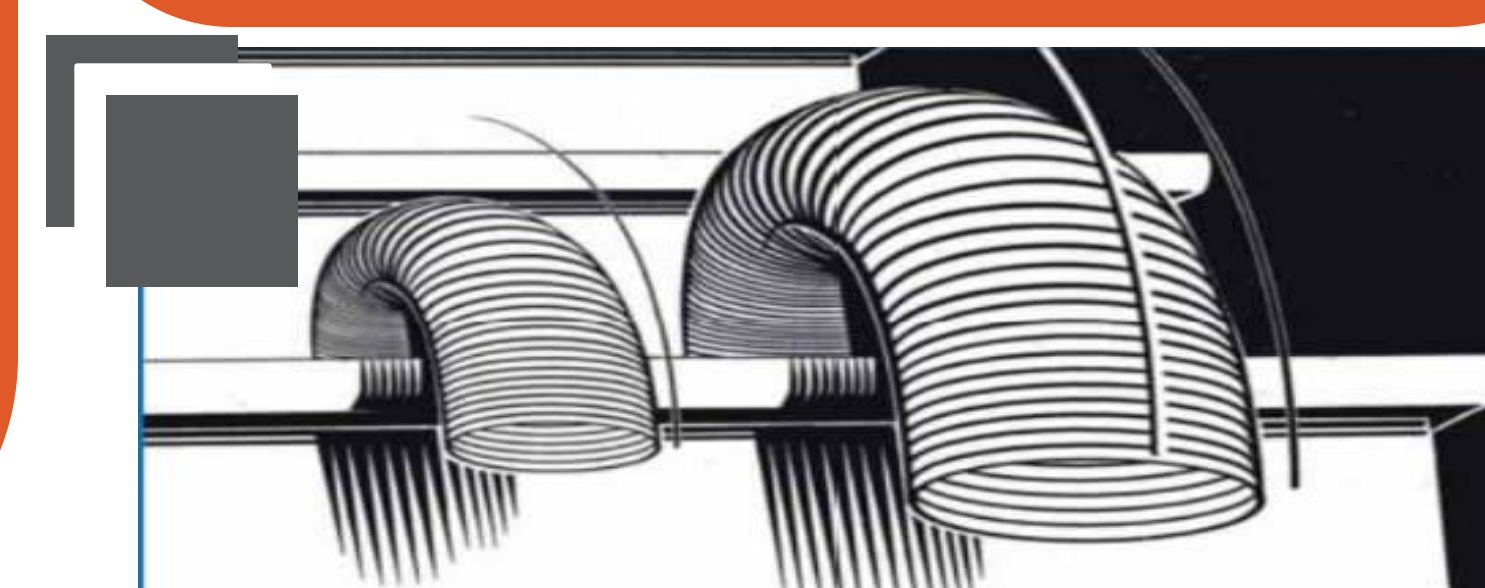
Safety and Reciprocity Quotient (SRQ):
- 0% stress: all residual energy → Autonomic Function
- 50% Stress: residual energy divided 50%/50%
- 100% stress: all residual energy → Tissue Storage

Tissue Storage Pathway
- Surplus stored as:
  1. Carbohydrate up to 2400 calories of storage
  2. Then remaining energy is stored in adipose tissue
  - Note: Hypertrophy training not modeled

Validation Strategy
- Conducted a targeted literature review to identify:
  1. Studies with constant calorie deficit but variable Glycemic index (GI) diets
  2. Studies with constant calorie deficit but variable stress Levels

Results

Predicted Weight Loss - Diet

Predicted Weight Loss [Consistent Calorie Deficit]

— Low Fat — High GI — Low GI

Predicted Weight Loss - Stress

Predicted Weight Loss [Consistent Calorie Deficit & GI]

— Stress 0% Max — Stress 50% Max — Stress 100% Max

Clinical Weight Loss - Diet [1]

EFFECT OF GLYCEMIC INDEX ON WEIGHT LOSS

— Low-GI ⋯ High-GI -- Low-Fat

Clinical Weight Loss - Stress [2]

Fig. 1. Standardized estimates of parallel multiple mediation model of the relationships of perceived stress to dietary intake, depressive symptoms, and weight change status. Note. Mos = Months. Dashed lines represent non-significant paths. Path analysis adjusted for intervention arm, age, education, income, marital status, employment, self-rated health status, height at baseline, baseline dietary intake, and baseline depressive symptoms. *p < .05; **p < .01; ***p < .001

Discussion

Our Model demonstrate how human weight change can be accurately predicted using thermodynamics to model the body as a heat engine. By introducing two continuous variable— Average Diet GI and SRQ—we capture how diet complexity and chronic stress shifts residual energy away from repair and toward fat storage.
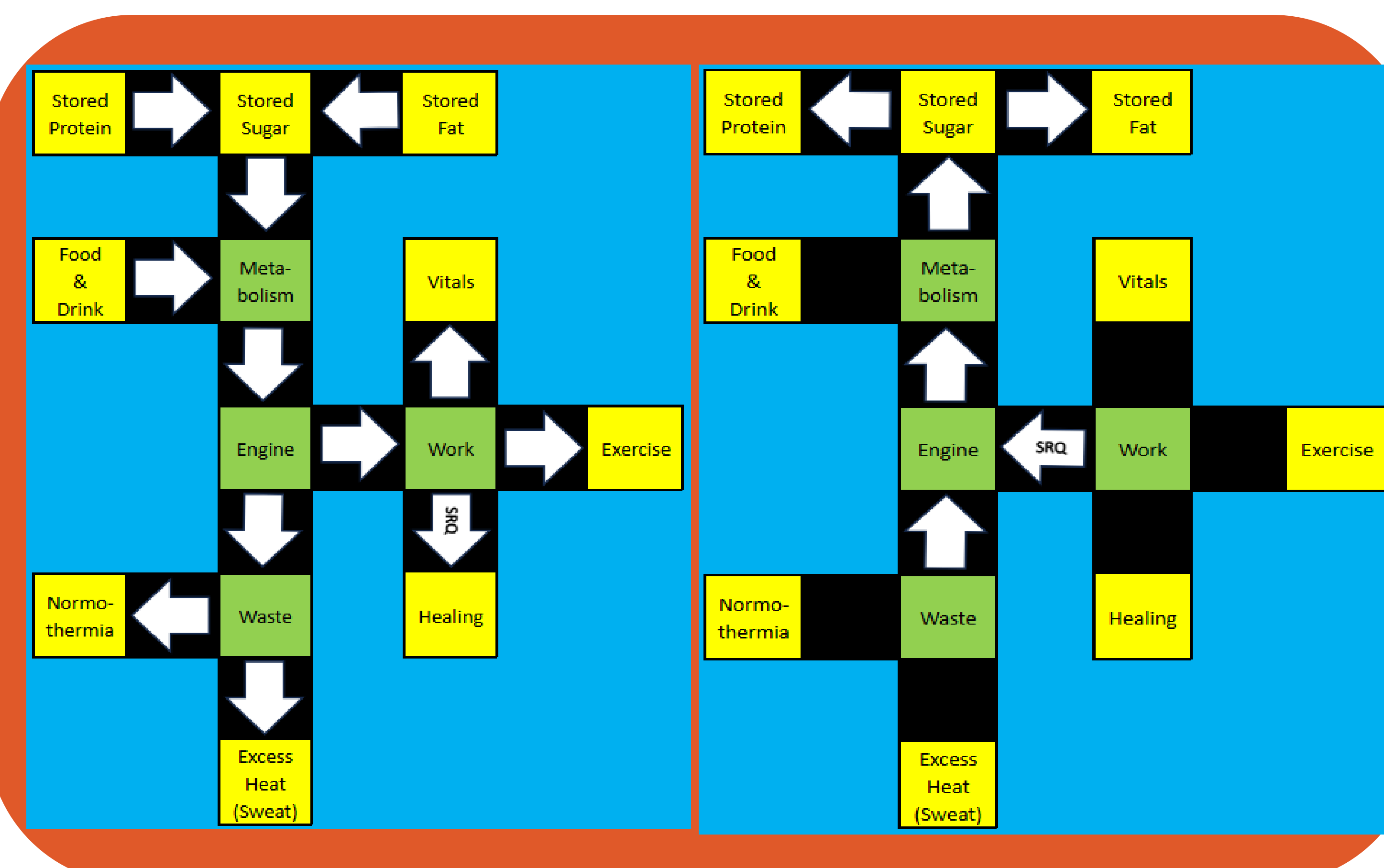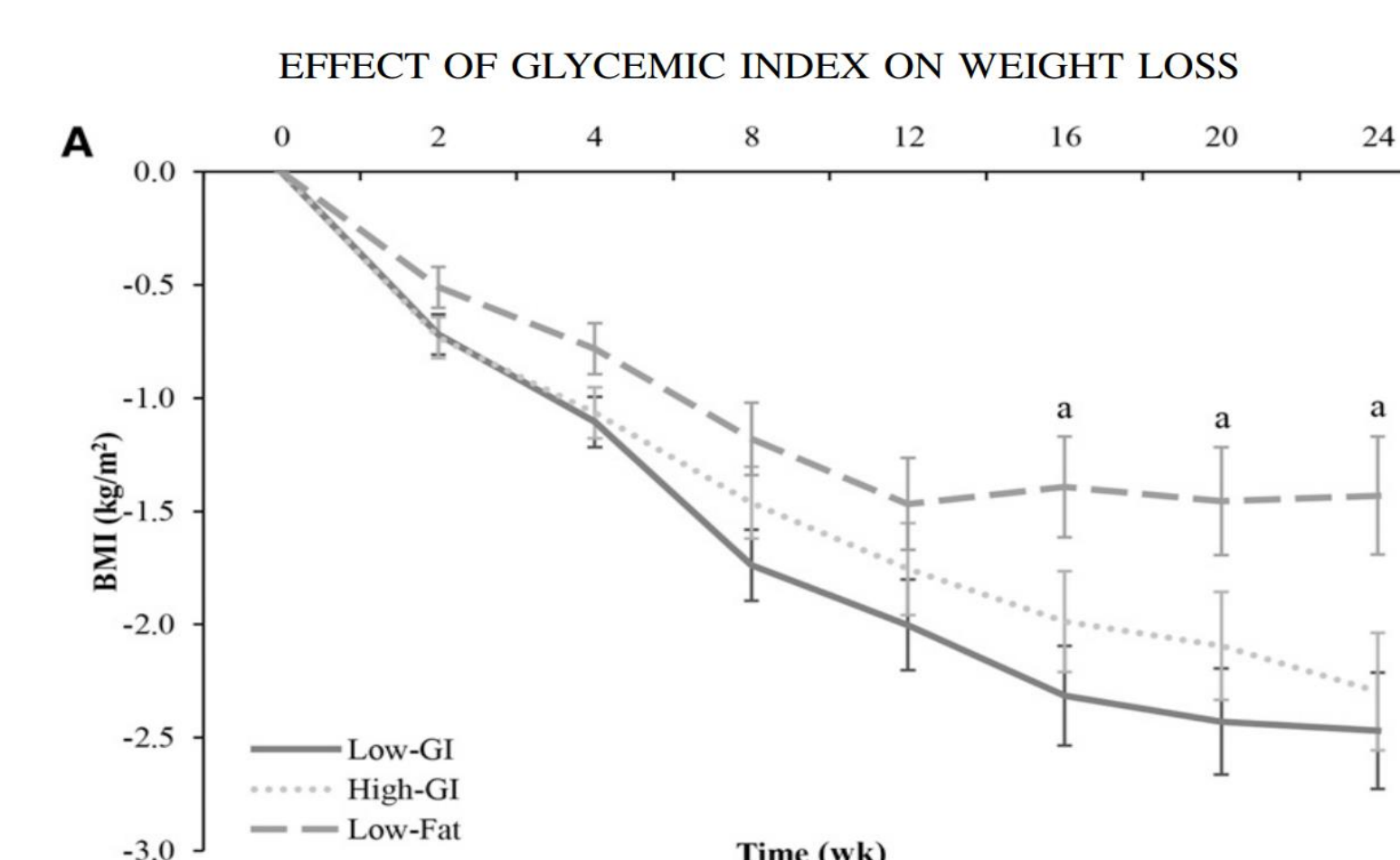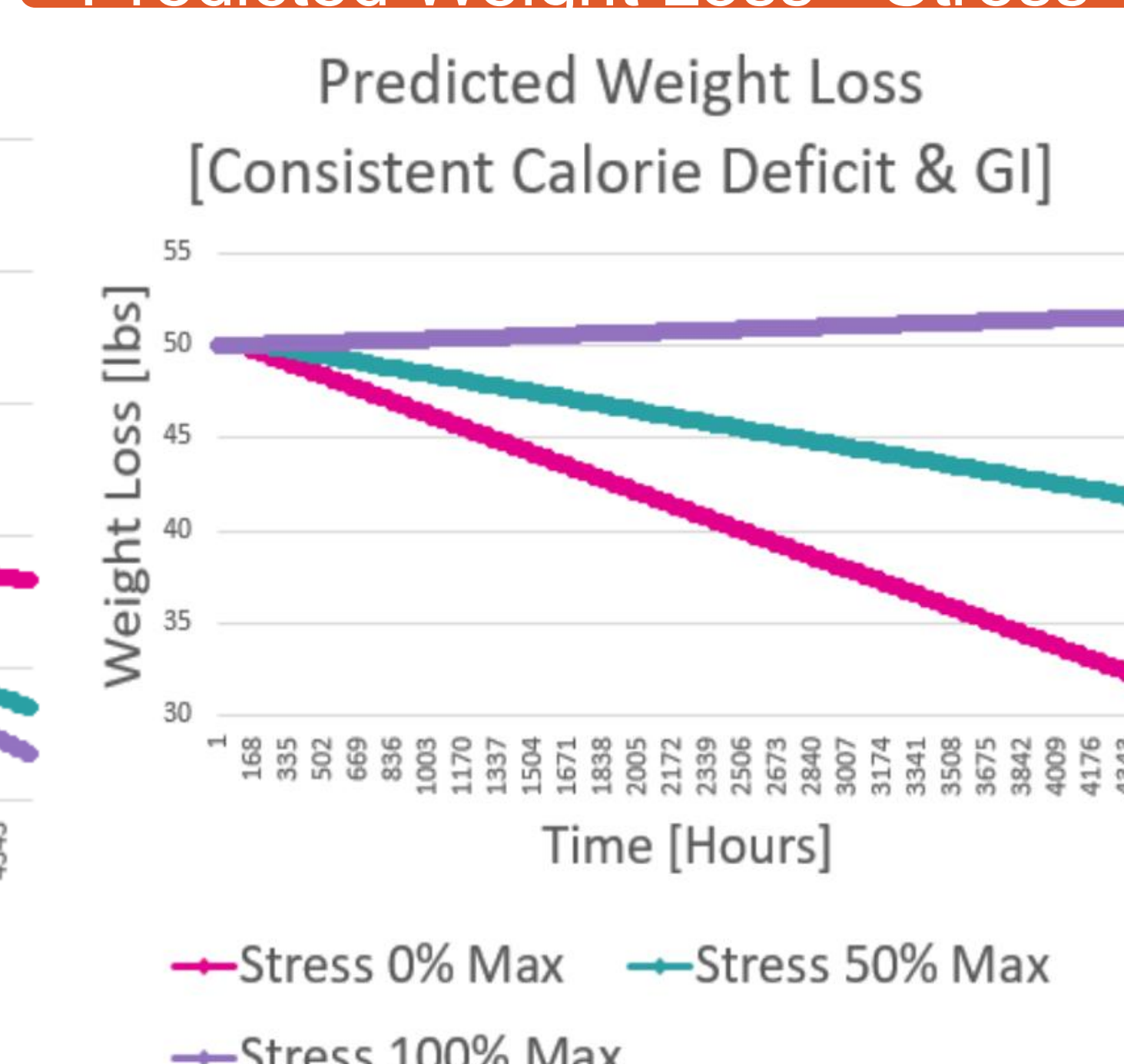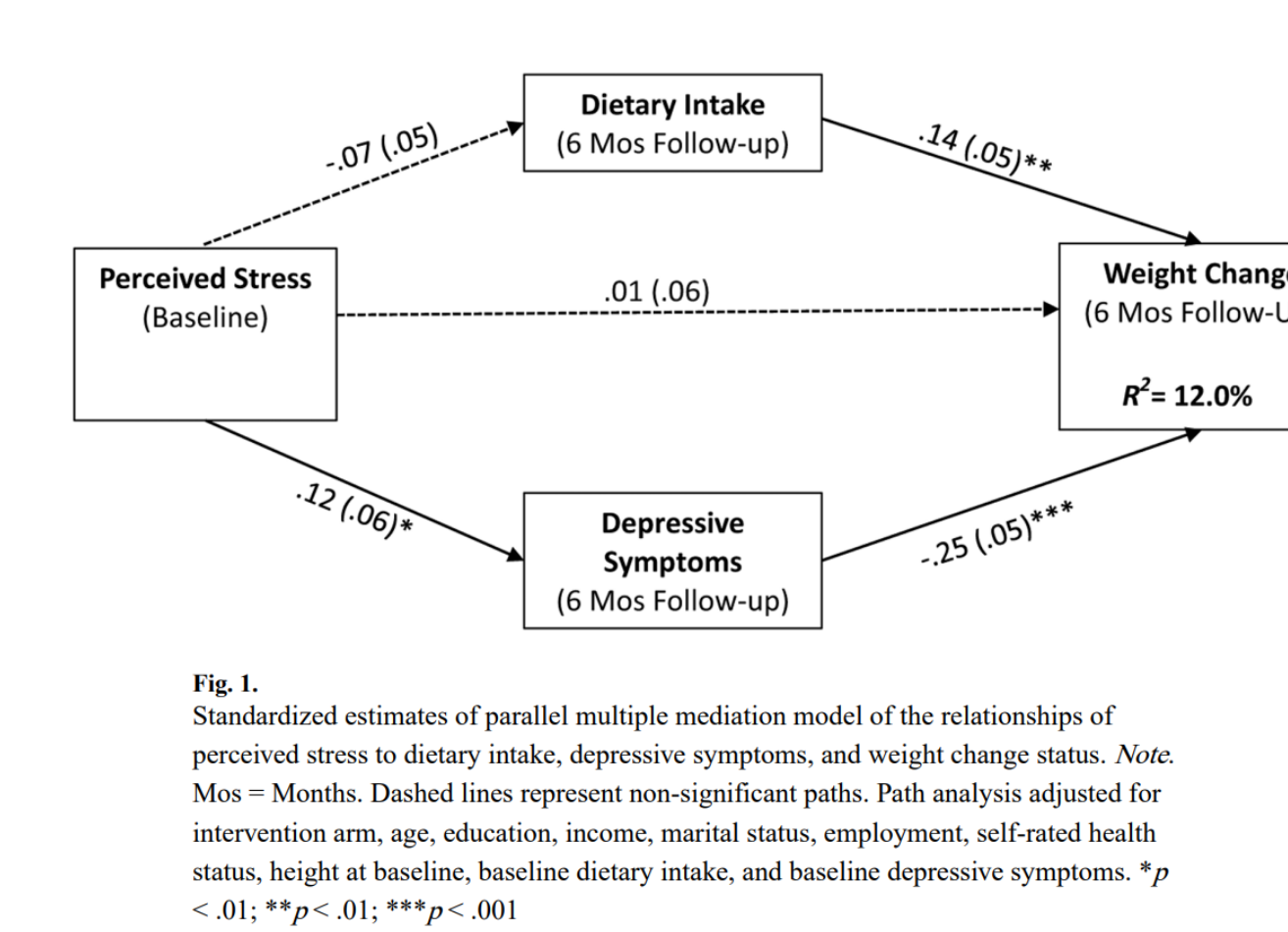
$$\Delta U = -Q - W + \text{Food energy}$$
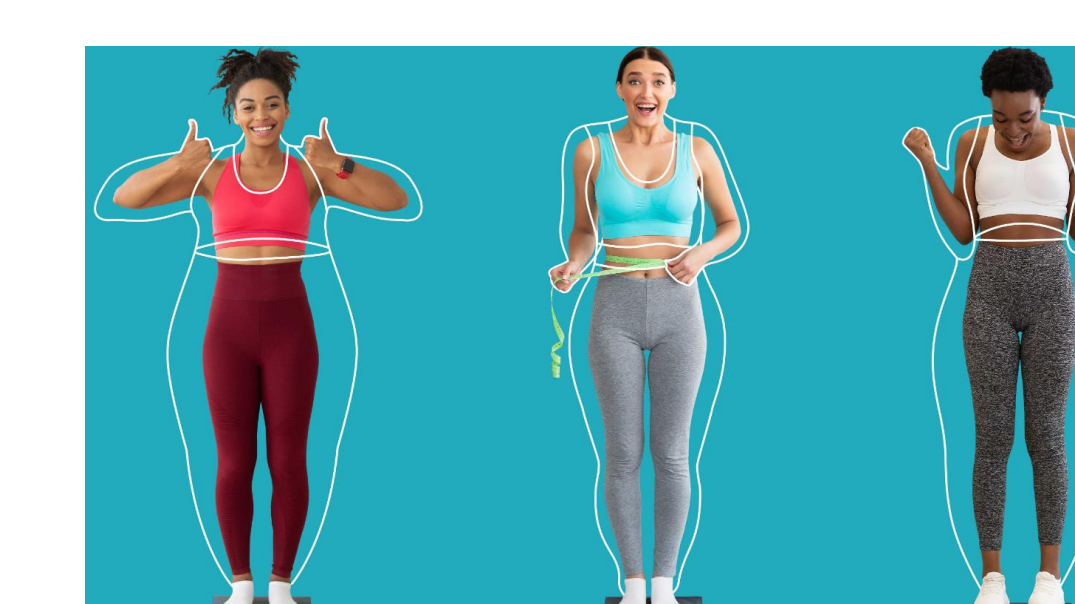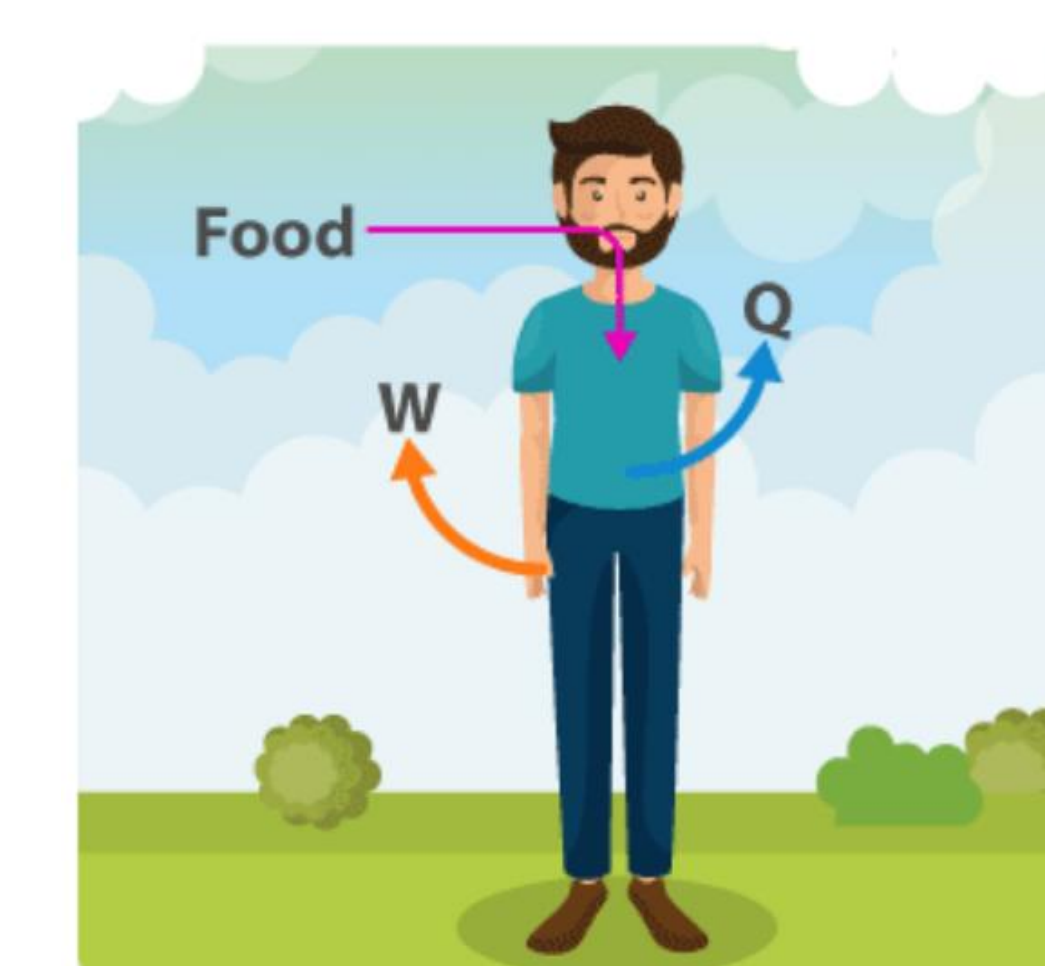
When calories are held constant SRQ and GI explain real-world variation in weight-loss outcomes.
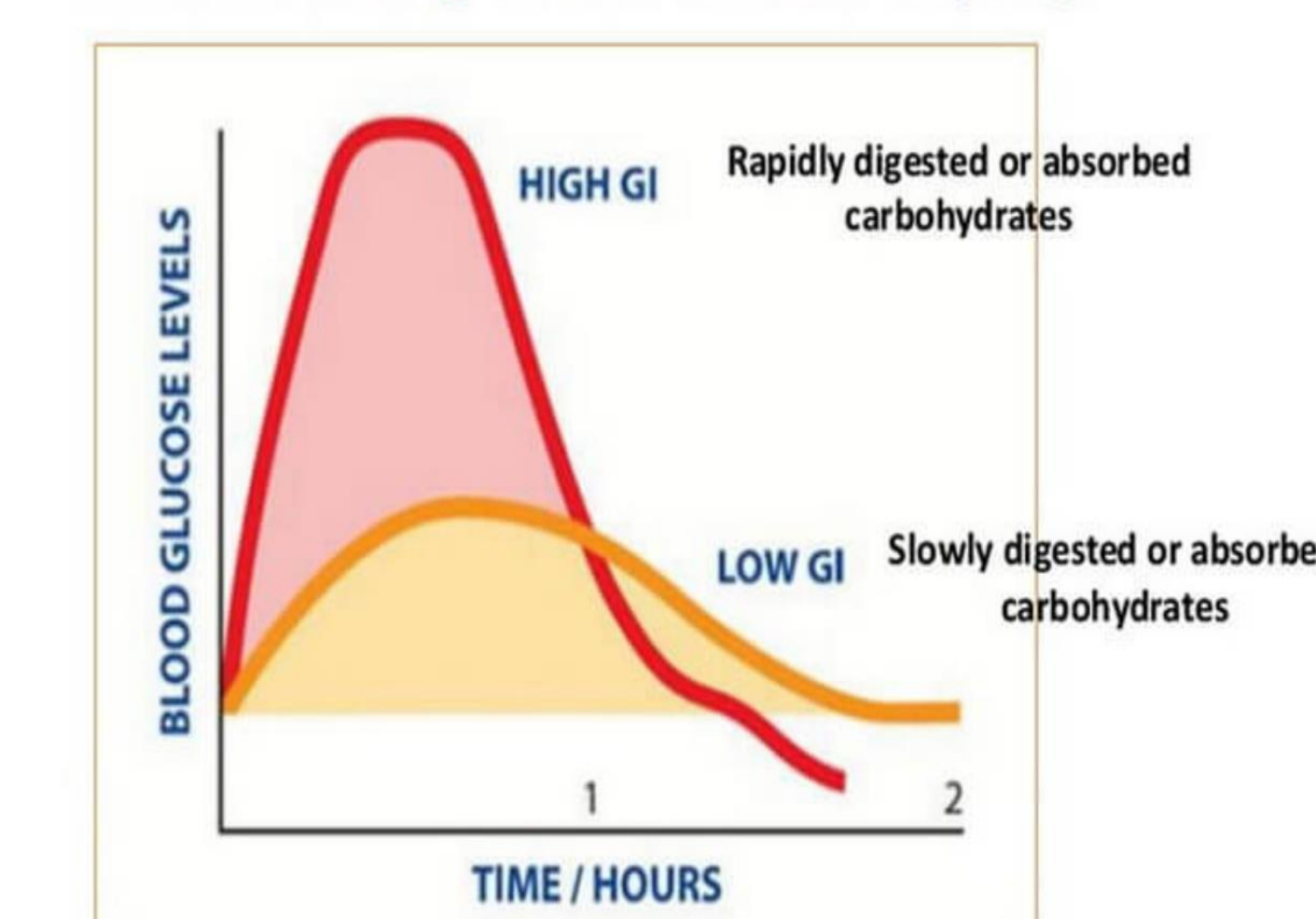
The model's ability to reproduce clinical trial results, including early plateaus and differential responses to glycemic load, suggests that stress physiology and diet quality are as important as caloric balance itself. This framework offers a unified, mechanistically coherent explanation for why patients following the "same calorie diet" often experience different results.

What is Glycemix Index (GI)

Conclusion

Our thermodynamically grounded Human Heat Engine model demonstrates that chronic stress (SRQ) and carbohydrate quality (GI) are major determinants of weight-loss variability, even when calories are identical. By accurately reproducing outcomes across clinical trials, the model offers a unified mechanism linking stress physiology, diet quality, and metabolic efficiency. This framework may help clinicians tailor interventions that target both metabolic fuel quality and perceived stress to improve real-world weight outcomes.

References

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2. Molina K, Baskin ML, Long D, Carson TL. Psychological and behavioral pathways between perceived stress and weight change in a behavioral weight loss intervention. J Behav Med. 2021 Dec;44(6):822-832. doi: 10.1007/s10865-021-00231-z. Epub 2021 May 18. PMID: 34003418; PMCID: PMC9105808.