

GI Reflects Absorption Speed Only Because It Is Cut at Two Hours; Uncut, the Area Depends Only on the Carbohydrate

— In a model of two compartments, where carbohydrate passes from the gut into the blood and then disappears from the blood, GI is the area of the blood-sugar rise compared with glucose — the separator is whether one asks how fast carbohydrate is absorbed or how much is absorbed in the end — [Paper 884]

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Abstract

It is easy to assume that GI (glycemic index) is a fixed property of a food, its tendency to raise blood sugar. This paper counts, in a two-compartment model of absorption and disappearance, what GI measures, by varying the time at which it is cut. No new theorem or law is claimed. First, cut at 2 hours, slower foods have lower GI: foods absorbed at 6, 3, 1.5, 0.75 and 0.4 per hour have GI 100.000000, 95.300562, 82.804347, 61.304428 and **40.752432** (Section 2). Second, extending the cut raises the GI of slow foods: the food absorbed at 0.4 reaches 69.090139 at 4 hours and **93.266208** at 8 hours (Section 2). Third, and this is the core. Uncut, every food has GI 100: even with absorption rates fifteenfold apart, the uncut area is set only by the carbohydrate divided by the rate of disappearance, and all five equal glucose (Section 3). Fourth, GL, which multiplies by the serving, is proportional to the serving's 2-hour area: for five foods, the ratio of GL to the serving's 2-hour area was the same within a relative difference of 10^{-9} (Section 3). Fifth, GI and GL orderings mostly disagree: for five foods with servings from 10 g to 100 g of carbohydrate, 8 of 10 pairs switch order (Section 3). Sixth, the separator is whether one asks how fast carbohydrate is absorbed or how much is absorbed in the end: GI, cut at a fixed time, reflects the former; the uncut area reflects only the latter (Section 4). **Keywords:** glycemic index, glycemic load, blood sugar, absorption rate, cut-off time.

Scope of this paper (scope note): No new theorem or law is claimed: that GI compares the 2-hour area of the blood-sugar rise with glucose, that GL multiplies GI by the carbohydrate in a serving, and the first-order two-compartment equations, are all known. No real foods are claimed: absorption rates and servings of foods A to E are model values matching no food's GI. Body functions are not included: insulin action, unabsorbed carbohydrate and combination with fat or protein are not included; all carbohydrate is assumed absorbed. No advice is given. What to eat is not stated. Relation to earlier papers: Paper 567 showed that only protein differs by nearly a third between the calorimeter and the label. This paper stands beside it. There the numbers on food labels were counted as moving with the convention of measurement. Here GI is counted as moving with the convention of when to cut. What is added is laying out GI for five foods and four cut times, checking that uncut all reach 100, checking that GL is proportional to the serving's 2-hour area, and placing the separator on speed versus the amount absorbed in the end.

1. Notation and the Question

Setting: D g of carbohydrate enters the gut, passes into the blood at rate k_a per hour, and disappears from the blood at rate $k_e = 1.0$ per hour. Let $B(t)$ be the blood-sugar rise, and compare the areas from 0 to T hours.

$$\int_0^T B dt = \frac{D k_a}{k_a - k_e} \left(\frac{1 - e^{-k_e T}}{k_e} - \frac{1 - e^{-k_a T}}{k_a} \right), \quad \int_0^\infty B dt = \frac{D}{k_e}$$

GI is the area for 50 g of a food's carbohydrate divided by that for 50 g of glucose ($k_a = 6$), times 100; GL is $\text{GI} \times \text{carbohydrate per serving} \div 100$. Areas were obtained from the formula and by following in Runge--Kutta steps (difference below 10^{-6}).

Question: what does GI measure about a food?

2. Cut Time and GI

Computation 2.1: for five foods, GI was computed cut at 2, 4 and 8 hours and uncut.

food	absorption (/h)	GI (2 h)	GI (4 h)	GI (8 h)	uncut
A	6	100.000000	100.000000	100.000000	100.000000
B	3	95.300562	99.438497	99.989932	100.000000
C	1.5	82.804347	97.135988	99.940822	100.000000
D	0.75	61.304428	87.503074	99.149051	100.000000
E	0.4	40.752432	69.090139	93.266208	100.000000

Observation 2.2

cut at 2 hours, slower foods have lower GI. Food E has GI 40.752432 at 2 hours, rising to 69.090139 and 93.266208 as the cut is extended: a slowly absorbed food still has carbohydrate in the gut at 2 hours, and that part does not enter the area.

3. Uncut Area and GL

Computation 3.1: for five foods with different servings, GL, the serving’s 2-hour area and the peak were computed.

food	serving (g)	GL	serving’s 2-hour area	peak
A	10	10.000000	8.375989	6.988271
B	25	23.825141	19.955911	14.433757
C	50	41.402173	34.678414	22.222222
D	80	49.043543	41.078817	25.312500
E	100	40.752432	34.134192	21.715341

Observation 3.2

this is the core. Uncut, every food has GI 100. Five foods with absorption rates fifteenfold apart all equal glucose in uncut area: the uncut area is D/k_e , and the absorption rate k_a drops out. GI reflects the speed of a food because of the 2-hour cut.

Observation 3.3

GL is proportional to the serving's 2-hour area and reorders GI. For five foods, the ratio of GL to the serving's 2-hour area was the same within a relative difference of 10^{-9} : GI falls from A to E, but GL is largest for D, and 8 of 10 pairs switch order.

4. The Separator

Observation 4.1

the separator is whether one asks how fast carbohydrate is absorbed or how much is absorbed in the end. GI, cut at 2 hours, reflects the former: the uncut area reflects only the latter, and if everything absorbable is absorbed, differences between foods vanish. GI is set by a food's property together with the convention of when to cut.

Observation 4.2

placed beside Paper 567. 567 showed that only protein differs by nearly a third between the calorimeter and the label. There, labelled energy moved with whether food is burned or used by the body. Here GI moves with the convention of when to cut.

Observation 4.3

what is not said. Real foods' GI, insulin action, unabsorbed carbohydrate and what to eat are not treated. What is shown is that GI reflects speed because of the cut.

5. Census and Closing

1. GI is a ratio of areas (Section 1): **against glucose.**
2. food E's 2-hour GI **40.752432** (Computation 2.1): **a slow food.**
3. **69.090139** at 4 hours (Computation 2.1): **rises when extended.**
4. **93.266208** at 8 hours (Computation 2.1): **rises further.**
5. **all 100 uncut** (Observation 3.2): **the core.**
6. **uncut area is D/k_e** (Observation 3.2): **absorption rate drops out.**
7. **GL proportional to the 2-hour area** (Observation 3.3): **within 10^{-9} .**
8. **GI and GL switch in 8 pairs** (Observation 3.3): **of 10.**
9. **formula and stepped area agree** (Section 1): **below 10^{-6} .**
10. **speed, or amount in the end** (Observation 4.1): **the separator; Paper 567.**

Closing: GI reflects how fast a food is absorbed only because it is cut at two hours; uncut, the blood-sugar area depends only on the amount of carbohydrate. A food absorbed at 0.4 per hour has GI 40.752432 cut at 2 hours, 93.266208 at 8 hours, and 100.000000 uncut, because the uncut area is the carbohydrate divided by the rate of disappearance, and the absorption rate drops out. GL, multiplying by the serving, is proportional to the serving's 2-hour area and switches order with GI in 8 of 10 pairs: GI is set by a food's property together with the convention of when to cut. Placed among the earlier papers: beside Paper 567's "labelled energy moves with how it is measured", we placed GI moving with when it is cut. To be honest: the foods are models, and neither insulin action nor unabsorbed carbohydrate is included.

References

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