

# The GH-Method

## Investigation of Linear Elastic Glucose Behavior with GH Modulus Linking Carbohydrates/Sugar Intake Amount and Incremental PPG Amount via Analogy of Young's Modulus from Engineering Strength of Materials Using GH-Method: Math-Physical Medicine, Parts 1, 2, 3 (No. 351b)

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### 1. PART 1: ONE PATIENT

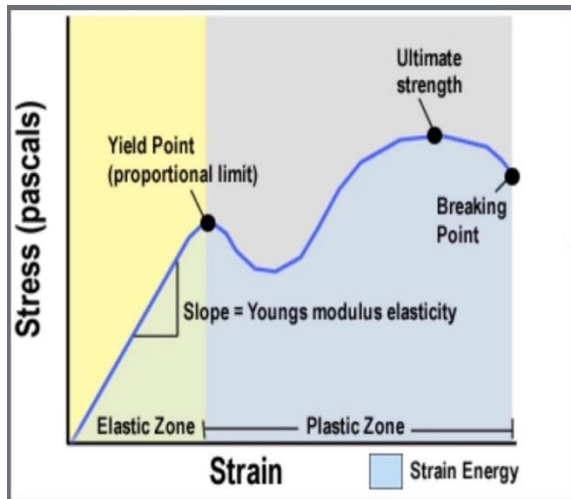


Figure 1: Stress-strain-Young's modulus, elastic zone vs. plastic zone.

(5/5/18-1/18/20) & (1/19/20-10/10/20)	Y2015 (7/1)	Y2016	Y2017	Y2018	Y2019	Y2020 (10/13)	Average
Carb/Sugar (grams)	14.46	15.47	14.19	15.47	13.19	12.40	14.20
Post-meal Walking (k-steps)	3.681	4.110	4.440	4.538	4.038	4.296	4.184
(5/5/18-1/18/20) & (1/19/20-10/10/20)	Y2015 (7/1)	Y2016	Y2017	Y2018	Y2019	Y2020 (10/13)	Average
Finger PPG	119	117	120	114	115	104	115
Finger PPG	119	120	117	117	114	109	116
Finger Daily	119	119	117	116	114	108	116
Predicted PPG = (PPG*0.97)+(Carbs*M2)-(Steps*S)	Y2015 (7/1)	Y2016	Y2017	Y2018	Y2019	Y2020 (10/13)	Average
Predicted Finger PPG	119	120	117	117	114	109	116
Measured Finger PPG	119	120	117	117	114	109	116
Equation Multipliers (5/5/18-10/10/20)	M2	M2	M2	M2	M2	M2	Average
Prediction Accuracy (Finger PPG)	100%	100%	100%	100%	100%	100%	100%
M2 for Finger PPG Prediction Equation	1.6	1.8	1.6	1.9	1.8	2.4	1.8
Predicted PPG = (PPG*0.97)+(Carbs*M2)-(Steps*S)	Y2015 (7/1)	Y2016	Y2017	Y2018	Y2019	Y2020 (10/13)	Average
Predicted Finger PPG	123	121	120	116	115	102	116
Measured Finger PPG	119	120	117	117	114	109	116
Equation Multipliers (5/5/18-10/10/20)	M2	M2	M2	M2	M2	M2	Average
Prediction Accuracy (Finger PPG)	103%	101%	103%	99%	101%	93%	100%
M2 for Finger PPG Prediction Equation	1.8	1.8	1.8	1.8	1.8	1.8	1.8

Figure 2: Raw data for the period of 7/1/2015 - 10/13/2020.

Predicted PPG = (PPG*0.97)+(Carbs*M2)-(Steps*S)	Y2015 (7/1)	Y2016	Y2017	Y2018	Y2019	Y2020 (10/13)	Average
Predicted Finger PPG	119	120	117	117	114	109	116
Finger PPG	119	120	117	117	114	109	116
Prediction Accuracy (Finger PPG)	100%	100%	100%	100%	100%	100%	100%
Predicted Finger Daily Glucose	119.28	119.42	117.38	116.36	114.38	107.74	116
Finger Daily Glucose	119.28	119.42	117.38	116.36	114.38	107.74	116
Prediction Accuracy (Finger Daily)	100%	100%	100%	100%	100%	100%	100%
Equation Multipliers (5/5/18-10/10/20)	M2	M2	M2	M2	M2	M2	Average
Finger PPG Prediction Equation	1.56	1.76	1.59	1.87	1.75	2.41	1.82
Finger Daily Prediction Equation	1.52	1.56	1.82	1.70	1.79	1.99	1.73
Predicted PPG = (PPG*0.97)+(Carbs*M2)-(Steps*S)	Y2015 (7/1)	Y2016	Y2017	Y2018	Y2019	Y2020 (10/13)	Average
Predicted Finger PPG	123	121	120	116	115	102	116
Finger PPG	119	120	117	117	114	109	116
Prediction Accuracy (Finger PPG)	103%	101%	103%	99%	101%	93%	100%
Predicted Finger Daily Glucose	122	122	116	117	114	104	116
Finger Daily Glucose	119	119	117	116	114	108	116
Prediction Accuracy (Finger Daily)	103%	102%	99%	100%	99%	97%	100%
Equation Multipliers (5/5/18-10/10/20)	M2	M2	M2	M2	M2	M2	Average
Finger PPG Prediction Equation	1.82	1.82	1.82	1.82	1.82	1.82	1.82
Finger Daily Prediction Equation	1.73	1.73	1.73	1.73	1.73	1.73	1.73

Figure 3: Calculated PPG prediction using constant M2 for both Case A and Case B for the period of 7/1/2015 - 10/13/2020.



Figure 4: Calculated PPG prediction using Case A (variable M2) to have 100% prediction accuracy for each year of the period of 7/1/2015 - 10/13/2020.

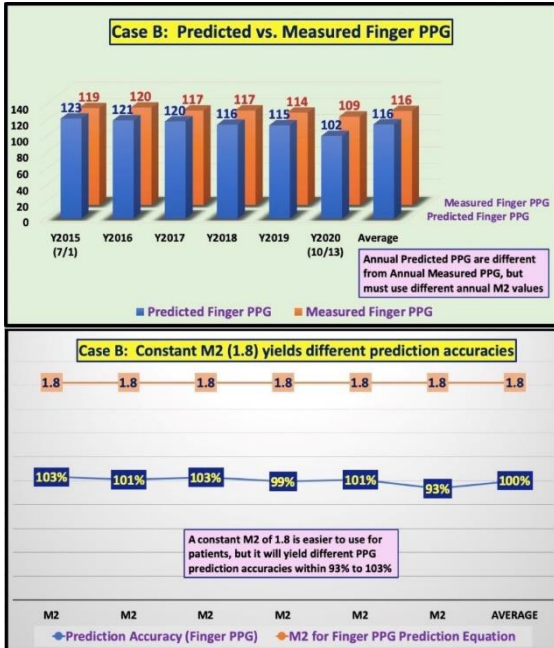


Figure 5: Calculated PPG prediction using Case B (constant M2) to have different prediction accuracy for each year (between 93% and 103%) of the period of 7/1/2015 - 10/13/2020.

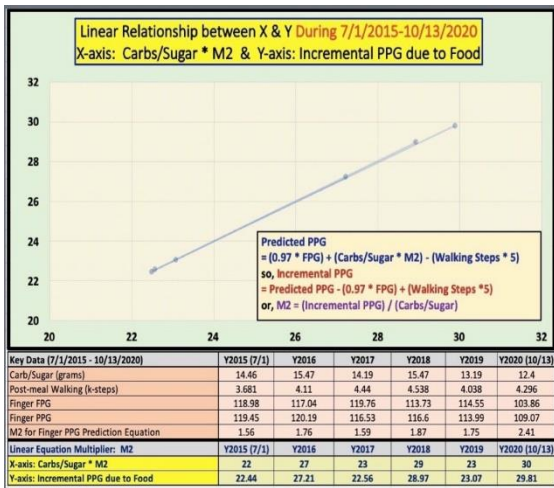


Figure 6: A "pseudo-linear" relationship between x-values and y-values during the "linear elastic" zone of 2015-2020.

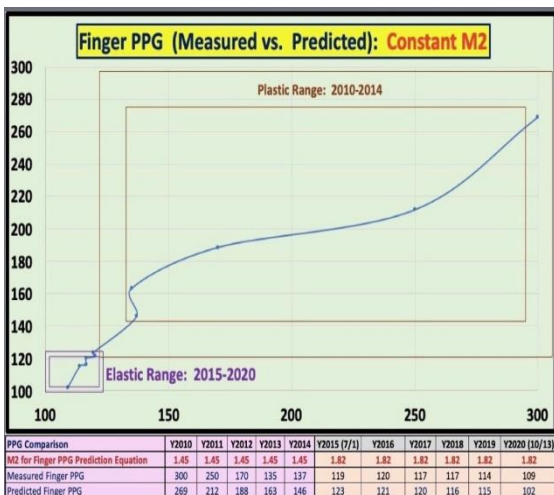


Figure 7: Discussion of the variety relationship between predicted PPG and measured PPG during 2010-2020 (both "pseudo-linear elastic" zone and "nonlinear plastic" zone).

## 2. PART 2: TWO PATIENTS

Male Sensor	1/18-2/18	2/18-3/18	3/18-4/18	4/18-5/18	5/18-6/18	6/18-7/18	7/18-8/18	8/18-9/18	9/18-10/18	Average
PPG (peak)	134.90	135.13	140.83	133.37	128.06	134.16	120.46	125.43	119.47	130.20
PPG (Average)	126	122	136	125	117	128	115	119	112	122
FPG (Average)	115.11	97.31	113.58	104.81	96.11	100.55	100.23	99.18	91.08	102.00
Carbs/Sugar (grams)	10.54	13.15	12.73	16.18	12.55	9.79	10.67	12.93	11.81	12.26
Walking (k-steps)	4.519	4.763	4.528	4.268	3.895	4.039	4.009	4.148	4.252	4.269
Female Sensor	1/18-2/18	2/18-3/18	3/18-4/18	4/18-5/18	5/18-6/18	6/18-7/18	7/18-8/18	8/18-9/18	9/18-10/18	Average
PPG (peak)	126.37	124.46	120.11	118.37	115.70	127.68	118.24	119.37	112.58	120.32
PPG (Average)	123	121	115	114	113	118	112	113	110	115
FPG (Average)	111.57	107.24	97.65	102.52	106.90	102.98	97.06	100.77	105.65	103.59
Carbs/Sugar (grams)	8.43	10.52	10.18	12.94	10.04	7.83	8.54	10.34	9.45	9.81
Walking (k-steps)	2.260	2.382	2.264	2.134	1.948	2.020	2.005	2.074	2.126	2.13
Male Predicted PPG	127	118	133	139	119	113	116	122	110	122
Male Prediction Accuracy	101%	97%	98%	111%	101%	88%	100%	102%	98%	100%
Female Predicted PPG	119	119	110	122	120	110	106	114	116	115
Female Prediction Accuracy	97%	99%	95%	108%	107%	93%	95%	101%	106%	100%
Male M2 value (Fixed)										3.6
Female M2 value (Fixed)										2.6
Male X: (Carbs*M2)	37.94	47.34	45.83	58.25	45.18	35.24	38.41	46.55	42.52	44.14
Male Y: (Pred PPG)-(0.97FPG)+(Steps*5)	37.94	47.34	45.83	58.25	45.18	35.24	38.41	46.55	42.52	44.14
Female X: (Carbs*M2)	21.92	27.35	26.48	33.65	26.10	20.36	22.19	26.89	24.56	25.50
Female Y: (Pred PPG)-(0.97FPG)+(Steps*5)	21.92	27.35	26.48	33.65	26.10	20.36	22.19	26.89	24.56	25.50

Figure 8: Raw data and calculations for fixed M2 value (1/18/2020 - 10/18/2020).

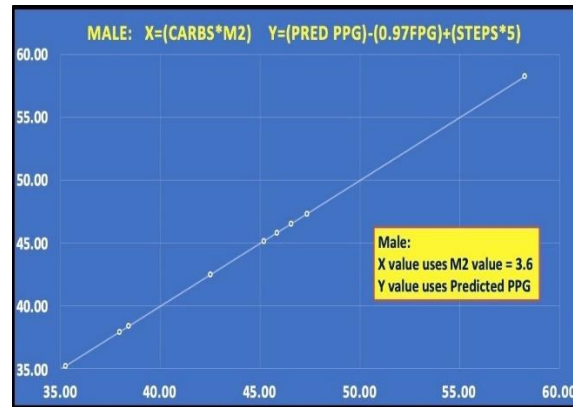


Figure 9: Male case using fixed M2 value of 3.6 (1/18/2020 - 10/18/2020).

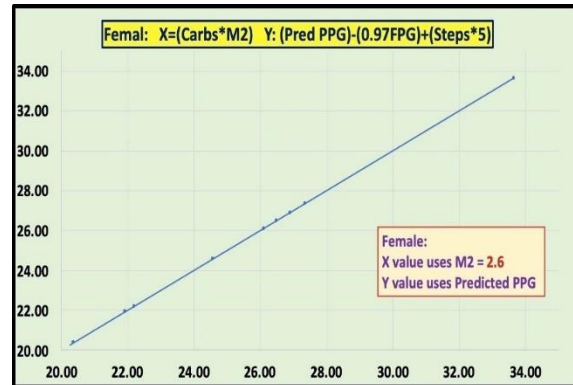


Figure 10: Female case using fixed M2 value of 2.6 (1/18/2020 - 10/18/2020).

Male Sensor	1/18-2/18	2/18-3/18	3/18-4/18	4/18-5/18	5/18-6/18	6/18-7/18	7/18-8/18	8/18-9/18	9/18-10/18	Average
PPG (peak)	134.90	135.13	140.83	133.37	128.06	134.16	120.46	125.43	119.47	130.20
Male Measured PPG (Average)	126	122	136	125	117	128	115	119	112	122
FPG (Average)	115.11	97.31	113.58	104.81	96.11	100.55	100.23	99.18	91.08	102.00
Carbs/Sugar (grams)	10.54	13.15	12.73	16.18	12.55	9.79	10.67	12.93	11.81	12.26
Walking (k-steps)	4.519	4.763	4.528	4.268	3.895	4.039	4.009	4.148	4.252	4.269
Female Sensor	1/18-2/18	2/18-3/18	3/18-4/18	4/18-5/18	5/18-6/18	6/18-7/18	7/18-8/18	8/18-9/18	9/18-10/18	Average
PPG (peak)	126.37	124.46	120.11	118.37	115.70	127.68	118.24	119.37	112.58	120.32
Female Measured PPG (Average)	123	121	115	114	113	118	112	113	110	115
FPG (Average)	111.57	107.24	97.65	102.52	106.90	102.98	97.06	100.77	105.65	103.59
Carbs/Sugar (grams)	8.43	10.52	10.18	12.94	10.04	7.83	8.54	10.34	9.45	9.81
Walking (k-steps)	2.260	2.382	2.264	2.134	1.948	2.020	2.005	2.074	2.126	2.13
Male X: (Carbs*M2)	37.07	51.29	48.02	44.94	43.53	50.85	38.14	43.80	45.04	44.74
Male Y: (Meas. PPG)-(0.97FPG)+(Steps*5)	37.07	51.29	48.02	44.94	43.53	50.85	38.14	43.80	45.04	44.74
Female X: (Carbs*M2)	25.69	28.60	31.84	25.02	18.61	28.57	27.48	25.79	18.35	25.55
Female Y: (Meas. PPG)-(0.97FPG)+(Steps*5)	25.69	28.60	31.84	25.02	18.61	28.57	27.48	25.79	18.35	25.55
Male Annual M2 (Variable)	3.5	3.9	3.8	2.8	3.5	5.2	3.6	3.4	3.8	3.7
Female Annual M2 (Variable)	3.0	2.7	3.1	1.9	1.9	3.6	3.2	2.5	1.9	2.7

Figure 11: Raw data and calculations for variable M2 values (1/18/2020 - 10/18/2020).

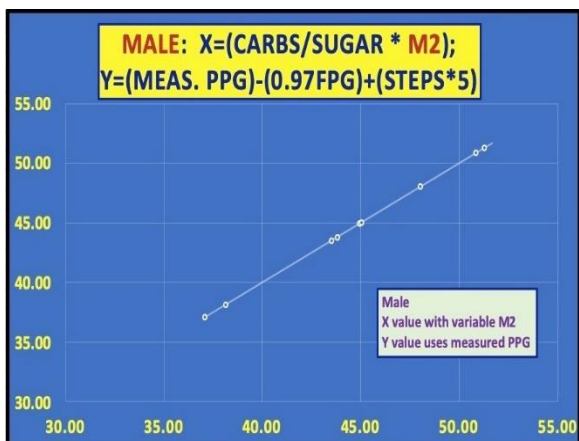


Figure 12: Male case using variable M2 values (1/18/2020 - 10/18/2020).

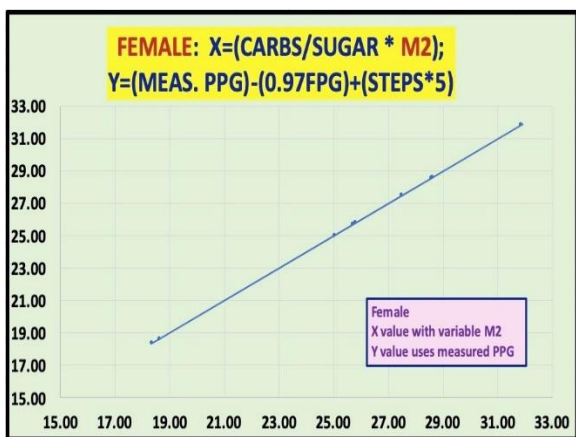


Figure 13: Female case using variable M2 values (1/18/2020 - 10/18/2020).

### 3. PART 3: THREE PATIENTS

Male Sensor	3/18-4/18	4/18-5/18	5/18-6/18	6/18-7/18	7/18-8/18	8/18-9/18	9/18-10/18	Average
PPG (peak)	141	133	128	134	120	125	119	129
Male Measured PPG	136	125	117	128	115	119	112	122
FPG (Average)	114	105	96	101	100	99	91	101
Carbs/Sugar (grams)	12.73	16.18	12.55	9.79	10.67	12.93	11.81	12.38
Walking (K-steps)	4.528	4.268	3.895	4.039	4.009	4.148	4.252	4.163
Male predicted PPG	133	139	119	113	116	122	110	122
Female Sensor	3/18-4/18	4/18-5/18	5/18-6/18	6/18-7/18	7/18-8/18	8/18-9/18	9/18-10/18	Average
PPG (peak)	120	118	116	128	118	119	113	119
Female Measured PPG	115	114	113	118	112	113	110	114
FPG (Average)	98	103	107	103	97	101	106	102
Carbs/Sugar (grams)	10.18	12.94	10.04	7.83	8.54	10.34	9.45	9.90
Walking (K-steps)	2.264	2.134	1.948	2.020	2.005	2.074	2.126	2.08
Female predicted PPG	110	122	120	110	106	114	116	114
Young Sensor	3/18-4/18	4/18-5/18	5/18-6/18	6/18-7/18	7/18-8/18	8/18-9/18	9/18-10/18	Average
PPG (peak)	132	102	108	105	123	106	107	112
Young Measured PPG	125	101	108	105	121	102	104	109
FPG (Average)	117	100	107	106	115	94	95	105
Carbs/Sugar (grams)	12.73	16.18	12.55	9.79	10.67	12.93	11.81	12.38
Walking (K-steps)	1.132	1.067	0.974	1.010	1.002	1.037	1.063	1.041
Young Predicted PPG with Fixed M2 of 1.0323	121	108	112	108	118	100	99	109
Young Predicted PPG with variable M2	125	101	108	105	121	102	104	109

Figure 14: Raw data and predicted PPG for the 7-months period of three patients.

Male X: (Carbs*M2)	48	45	44	51	38	44	45	45
Male Y: (Meas PPG)-(0.97FPG)+(Steps*5)	48	45	44	51	38	44	45	45
Female X: (Carbs*M2)	32	25	19	29	27	26	18	25
Female Y: (Meas. PPG)-(0.97FPG)+(Steps*5)	32	25	19	29	27	26	18	25
Young X: (Carbs*M2)	13	17	13	10	11	13	12	13
Young Y: (Meas. PPG)-(0.97FPG)+(Steps*5)	13	17	13	10	11	13	12	13
Male M2 (Variable)	3.8	2.8	3.5	5.2	3.6	3.4	3.8	3.7
Female M2 (Variable)	3.1	1.9	1.9	3.6	3.2	2.5	1.9	2.6
Young M2 (Variable)	1.3	0.6	0.7	0.7	1.4	1.2	1.4	1.0

Figure 15: Calculated x and y components using variable M2 values for the 7-months period of three patients.

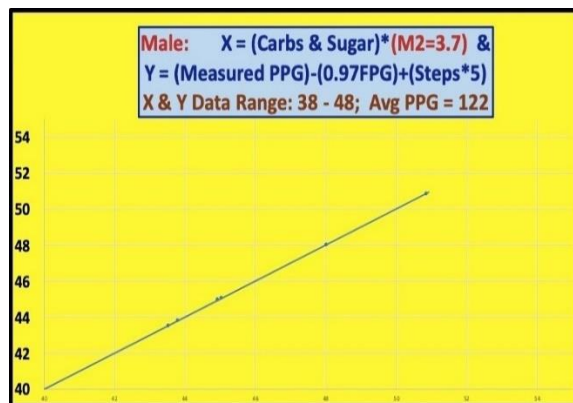


Figure 16: Linear elastic glucose behavior between carbs/sugar input and incremental PPG output for male case during the 7-months period.

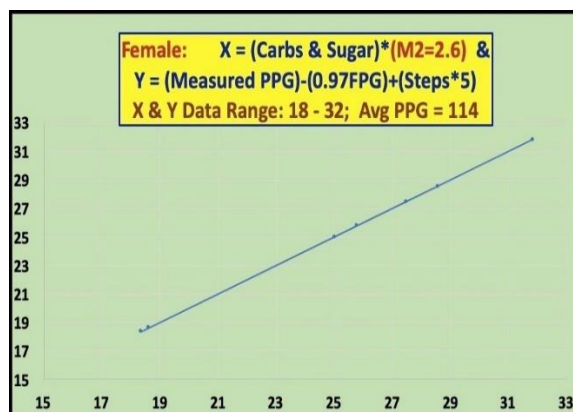


Figure 17: Linear elastic glucose behavior between carbs/sugar input and incremental PPG output for female case during the 7-months period.

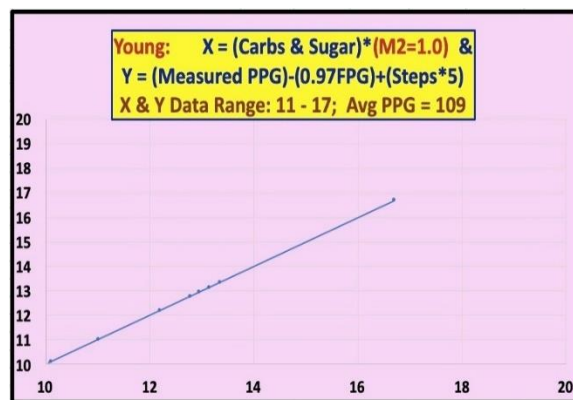


Figure 18: Linear elastic glucose behavior between carbs/sugar input and incremental PPG output for young case during the 7-months period.