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Research Article

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Investigation of Two Different Postprandial Plasma Glucoses with Fasting Glucose, Body Weight, Carbohydrates and Sugar Intake, and Post-Meal Walking Steps by Consuming Liquid Phase Egg Meals and Solid Phase Egg Meals Based on Viscoplastic Energy Model of GH-Method: Math-Physical Medicine (No. 1049)

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Abstract
The author investigated the pathophysiological mechanisms responsible for the differences in postprandial plasma glucose (PPG) levels between liquid egg meals, such as egg drop soup, and solid egg meals, like pan-fried or hard-boiled eggs. Base on information he read, the observed variations in PPG are linked to the rates of digestion, gastric emptying, and absorption within the gastrointestinal system. However, these descriptions of delay in the digestion process cannot fully explain the immediate rise in PPG levels observed within the first 15 minutes after consuming food he has observed from his collected PPG dataset. The author's prior research papers observed that his collected PPG waveforms for these two different types of meals significantly differ from the initial intake to the peak at approximately 60 minutes, and continuing up to 180 minutes after eating. This indicates that the differences are not solely based on gastrointestinal processes, but are also closely associated with the neural communication system and brain function.

His hypothesis posits that upon the arrival of food in the stomach, a signal is immediately sent to the brain indicating the physical phase of the food (liquid or solid). The brain then treat those liquid food similarly to water drinking which are different from those solid food, triggering different amounts of glucose production in the liver and insulin production in the pancreas, thus affecting the PPG waveforms and resulting in distinct PPG values for liquid versus solid meals, as shown in the attached figure.

The author analyzed two sets of PPG data (liquid versus solid egg meals) against four consistent variables: fasting plasma glucose in early morning (FPG), body weight (BW), carbohydrate or sugar intake (Carbs), and post-meal walking steps (Steps). Using the space-domain Viscoplastic medicine energy method from engineering, the energy associations between these two different PPG outcomes and those four identical influential variables were calculated.

***In summary,** the findings are threefold:*
*First, high correlations were found between liquid egg PPG versus FPG (73%) and BW (93%), while the other six correlations were lower or insignificant, highlighting **the distinct nature of egg meals are discrete in time-domain which lack of a continuous pattern.***

*Second, the Space-Domain Viscoplastic Medicine Technology (SD-VMT) energy ratios showed that **for both meal types, FPG was the most significant contributor to energy, while physical activity contributed the least.***

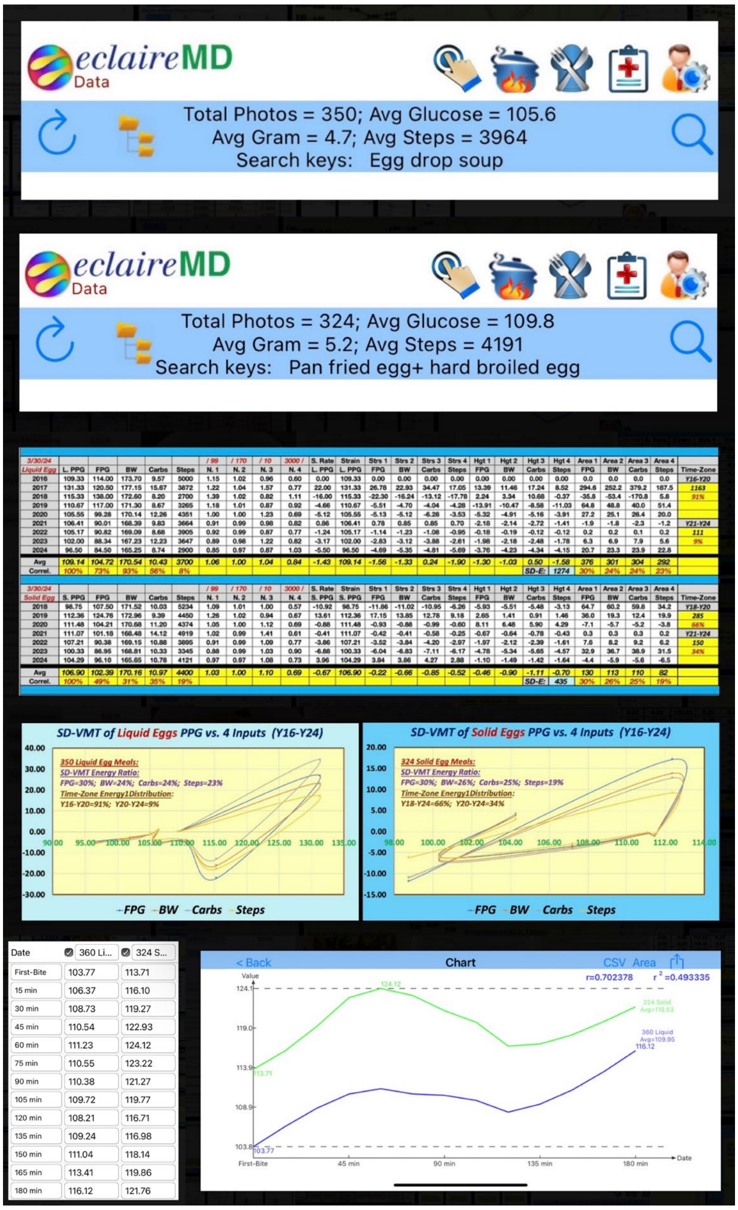
<u>For 350 liquid egg meals:</u>
FPG = 30%
BW = 24%
Carbs = 24%
Steps = 23%
<u>For 324 solid egg meals:</u>
FPG = 30%

BW = 26%
Carbs = 25%

Third, the time-zone energy distribution indicated ***a higher contribution in earlier years compared to more recent ones.***
<u>For 350 liquid egg meals:</u>
Y2016-Y2020 = 91%
Y2021-Y2024 = 9%
<u>For 324 solid egg meals:</u>
Y2018-Y2020 = 66%
Y2021-Y2024 = 34%

Key Message

Liquid meals can significantly impact brain processing to produce lower PPG levels, beneficial for type 2 diabetes (T2D) management. Nonetheless, the pancreatic beta cells' insulin function, as indicated by FPG in early morning, remains the most influential factor. Body weight closely correlates with FPG. Carbohydrate and sugar intake is more significant than post-meal exercise, although both are important for PPG management.



Viscoelastic Medicine theory (VMT #447):

Investigation of two different postprandial plasma glucoses with fasting glucose, body weight, carbohydrates and sugar intake, and post-meal walking steps by consuming liquid phase egg meals and solid phase egg meals based on viscoplastic energy model of GH-Method: Math-Physical Medicine (No. 1049)

1. Introduction

The author investigated the pathophysiological mechanisms responsible for the differences in postprandial plasma glucose (PPG) levels between liquid egg meals, such as egg drop soup, and solid egg meals, like pan-fried or hard-boiled eggs. Base on information he read, the observed variations in PPG are linked to the rates of digestion, gastric emptying, and absorption within the gastrointestinal system. However, these descriptions of delay in the digestion process cannot fully explain the immediate rise in PPG levels observed within the first 15 minutes after consuming food he has observed from his collected PPG dataset. The author's prior research papers observed that his collected PPG waveforms for these two different types of meals significantly differ from the initial intake to the peak at approximately 60 minutes, and continuing up to 180 minutes after eating. This indicates that the differences are not solely based on gastrointestinal processes, but are also closely associated with the neural communication system and brain function.

His hypothesis posits that upon the arrival of food in the stomach, a signal is immediately sent to the brain indicating the physical phase of the food (liquid or solid). The brain then treat those liquid food similarly to water drinking which are different from those solid food, triggering different amounts of glucose production in the liver and insulin production in the pancreas, thus affecting the PPG waveforms and resulting in distinct PPG values for liquid versus solid meals, as shown in the attached figure.

The author analyzed two sets of PPG data (liquid versus solid egg meals) against four consistent variables: fasting plasma glucose in early morning (FPG), body weight (BW), carbohydrate or sugar intake (Carbs), and post-meal walking steps (Steps). Using the space-domain Viscoplastic medicine energy method from engineering, the energy associations between these two different PPG outcomes and those four identical influential variables were calculated.

2. Biomedical and Engineering or Technical Information

The following sections contain excerpts and concise information on meticulously reviewed by the author of this paper. The author has adopted this approach as an alternative to including a conventional reference list at the end of this document, with the intention of optimizing his valuable research time. It is essential to clarify that these sections do not constitute part of the author's original contribution but have been included to aid the author in his future reviews and offer valuable insights to other readers with an interest in these subjects.

3. Pathophysiological Explantions of Liquid Phase Food PPG Versus Solid Phase Foods PPG

Postprandial plasma glucose (PPG) refers to the level of blood sugar after eating. The pathophysiological mechanisms underlying the differences in PPG responses to liquid phase foods versus solid phase foods are multifaceted and involve several aspects:

Gastric Emptying Rate

One of the primary factors influencing PPG is the rate of gastric emptying. Liquids generally pass through the stomach more quickly than solids. This rapid transit can lead to a faster absorption of glucose in the small intestine and a quicker, possibly higher, spike in blood glucose levels.

Digestion and Absorption Rates

The physical form of food affects the rate at which it is digested and absorbed. Solid foods require more mechanical and enzymatic processing in the digestive tract, which can slow down the release and absorption of glucose. In contrast, liquids, especially those high in simple sugars, can be absorbed more quickly, leading to a more rapid increase in PPG.

Hormonal Responses

The ingestion of food triggers the release of various gut hormones that play a role in regulating blood glucose levels. For instance, the incretin hormones (like GLP-1 and GIP) are released in response to food intake and enhance insulin secretion. The response of these hormones can vary depending on whether the food is in solid or liquid form, potentially influencing the PPG differently.

Insulin Response

The rate of glucose appearance in the bloodstream influences the insulin response. Since liquids can lead to a faster increase in blood glucose, they may also cause a more rapid and possibly larger insulin response to facilitate glucose uptake by the cells.

Satiety and Subsequent Food Intake

Solid foods generally provide more satiety than liquids, due to their higher fiber content and the mechanical processing required for digestion. This can affect subsequent food intake and, indirectly, the overall glycemic control and PPG in the longer term.

Understanding these mechanisms is crucial for managing dietary intake, especially for individuals with glucose metabolism disorders like diabetes, as it helps in selecting appropriate foods to maintain better glycemic control.

4. MPM Background

To learn more about his developed GH-Method: math-physical medicine (MPM) methodology, readers can read the following three papers selected from his published 760+ papers.

The first paper, No. 386 (Reference 1) describes his MPM methodology in a general conceptual format. The second paper, No. 387 (Reference 2) outlines the history of his personalized diabetes research, various application tools, and the differences between biochemical medicine (BCM) approach versus the MPM approach. The third paper, No. 397 (Reference 3) depicts a general flow diagram containing ~10 key MPM research methods and different tools.

5. The Author's Diabetes History

The author was a severe T2D patient since 1995. He weighed

220 lb. (100 kg) at that time. By 2010, he still weighed 198 lb. with an average daily glucose of 250 mg/dL (HbA1C at 10%). During that year, his triglycerides reached 1161 (high risk for CVD and stroke) and his albumin-creatinine ratio (ACR) at 116 (high risk for chronic kidney disease). He also suffered from five cardiac episodes within a decade. In 2010, three independent physicians warned him regarding the need for kidney dialysis treatment and the future high risk of dying from his severe diabetic complications.

In 2010, he decided to self-study endocrinology with an emphasis on diabetes and food nutrition. He spent the entire year of 2014 to develop a metabolism index (MI) mathematical model. During 2015 and 2016, he developed four mathematical prediction models related to diabetes conditions: weight, PPG, fasting plasma glucose (FPG), and HbA1C (A1C). Through using his developed mathematical metabolism index (MI) model and the other four glucose prediction tools, by the end of 2016, his weight was reduced from 220 lbs. (100 kg) to 176 lbs. (89 kg), waistline from 44 inches (112 cm) to 33 inches (84 cm), average finger-piercing glucose from 250 mg/dL to 120 mg/dL, and A1C from 10% to ~6.5%. One of his major accomplishments is that he no longer takes any diabetes-related medications since 12/8/2015.

In 2017, he achieved excellent results on all fronts, especially his glucose control. However, during the pre-COVID period, including both 2018 and 2019, he traveled to ~50 international cities to attend 65+ medical conferences and made ~120 oral presentations. This hectic schedule inflicted damage to his diabetes control caused by stress, dining out frequently, post-meal exercise disruption, and jet lag, along with the overall negative metabolic impact from the irregular life patterns; therefore, his glucose control was somewhat affected during the two-year traveling period of 2018-2019.

He started his COVID-19 self-quarantined life on 1/19/2020. By 10/16/2022, his weight was further reduced to ~164 lbs. (BMI 24.22) and his A1C was at 6.0% without any medication intervention or insulin injection. In fact, with the special COVID-19 quarantine lifestyle since early 2020, not only has he written and published ~500 new research articles in various medical and engineering journals, but he has also achieved his best health conditions for the past 27 years. These achievements have resulted from his non-traveling, low-stress, and regular daily life routines. Of course, his in-depth knowledge of chronic diseases, sufficient practical lifestyle management experiences, and his own developed high-tech tools have also contributed to his excellent health improvements.

On 5/5/2018, he applied a continuous glucose monitoring (CGM) sensor device on his upper arm and checks his glucose measurements every 5 minutes for a total of 288 times each day. Furthermore, he extracted the 5-minute intervals from every 15-minute interval for a total of 96 glucose data each day stored in his computer software.

Through the author's medical research work over 40,000 hours and read over 4,000 published medical papers online in the past 13 years, he discovered and became convinced that good life habits of not smoking, moderate or no alcohol intake, avoiding illicit drugs; along with eating the right food with well-balanced nutrition, persistent exercise, having a sufficient and good quality of sleep, reducing all kinds of unnecessary stress, maintaining a regular daily life routine contribute to the risk reduction of having many diseases, including CVD, stroke, kidney problems, micro blood vessels issues, peripheral nervous system problems, and even cancers and dementia. In addition, a long-term healthy lifestyle can even "repair" some damaged internal organs, with different required time-length depending on the particular organ's cell lifespan. For example, he has "self-repaired" about 35% of his damaged pancreatic beta cells during the past 10 years.

6. Energy Theory

The human body and organs have around 37 trillion live cells which are composed of different organic cells that require energy infusion from glucose carried by red blood cells; and energy consumption from labor-work or exercise. When the residual energy (resulting from the plastic glucose scenario) is stored inside our bodies, it will cause different degrees of damage or influence to many of our internal organs.

According to physics, energies associated with the glucose waves are proportional to the square of the glucose amplitude. The residual energies from elevated glucoses are circulating inside the body via blood vessels which then impact all of the internal organs to cause different degrees of damage or influence, e.g. diabetic complications. Elevated glucose (hyperglycemia) causes damage to the structural integrity of blood vessels. When it combines with both hypertension (rupture of arteries) and hyperlipidemia (blockage of arteries), CVD or Stroke happens. Similarly, many other deadly diseases could result from these excessive energies which would finally shorten our lifespan. For an example, the combination of hyperglycemia and hypertension would cause micro-blood vessel's leakage in kidney systems which is one of the major cause of CKD.

The author then applied Fast Fourier Transform (FFT) operations to convert the input wave from a time domain into a frequency domain. The y-axis amplitude values in the frequency domain indicate the proportional energy levels associated with each different frequency component of input occurrence. ***Both output symptom value (i.e. strain amplitude in the time domain) and output symptom fluctuation rate (i.e. the strain rate and strain frequency) are influencing the energy level (i.e. the Y-amplitude in the frequency domain).***

Currently, many people live a sedentary lifestyle and lack sufficient exercise to burn off the energy influx which causes them to become overweight or obese. Being overweight and having obesity leads to a variety of chronic diseases, particularly diabetes. In addition, many types of processed food add unnecessary ingredients and harmful chemicals that are toxic to the bodies, which lead to the development of many other deadly diseases, such as cancers. For example, ~85% of worldwide diabetes patients are overweight, and ~75% of patients with cardiac illnesses or surgeries have diabetes conditions.

In engineering analysis, when the load is applied to the structure, it bends or twists, i.e. deform; however, when the load is removed, it will either be restored to its original shape (i.e, elastic case) or remain in a deformed shape (i.e. plastic case). In a biomedical system, the glucose level will increase after eating carbohydrates or sugar from food; therefore, the carbohydrates and sugar function as the energy supply. After having labor work or exercise, the glucose level will decrease. As a result, the exercise burns off the energy, which is similar to load removal in the engineering case. In the biomedical case, both processes of energy influx and energy dissipation take some time which is not as simple and quick as the structural load removal in the engineering case. Therefore, the age difference and 3 input behaviors are "dynamic" in nature, i.e. time-dependent. *This time-dependent nature leads to a "viscoelastic or viscoplastic" situation.* ***For the author's case, it is "viscoplastic" since most of his biomarkers are continuously improved during the past 13-year time window.***

Time-Dependent output Strain and Stress of (Viscous Input*Output Rate)

Hooke's law of linear elasticity is expressed as:

Strain (ε: epsilon)
= Stress (σ: sigma) / Young's modulus (E)

For biomedical glucose application, his developed linear elastic glucose theory (LEGT) is expressed as:

PPG (strain) = carbs/sugar (stress) * GH.p-Modulus (a positive number) + post-meal walking k-steps * GH.w-Modulus (a negative number)

Where GH.p-Modulus is reciprocal of Young's modulus E.

However, in viscoelasticity or viscoplasticity theory, the stress is expressed as:

Stress
= viscosity factor (η: eta) * strain rate (dε/dt)

Where strain is expressed as Greek epsilon or ε.

In this article, in order to construct an "ellipse-like" diagram in a stress-strain space domain (e.g. "hysteresis loop") covering both the positive side and negative side of space, he has modified the definition of strain as follows:

Strain
= (body weight at certain specific time instant)

He also calculates his strain rate using the following formula:

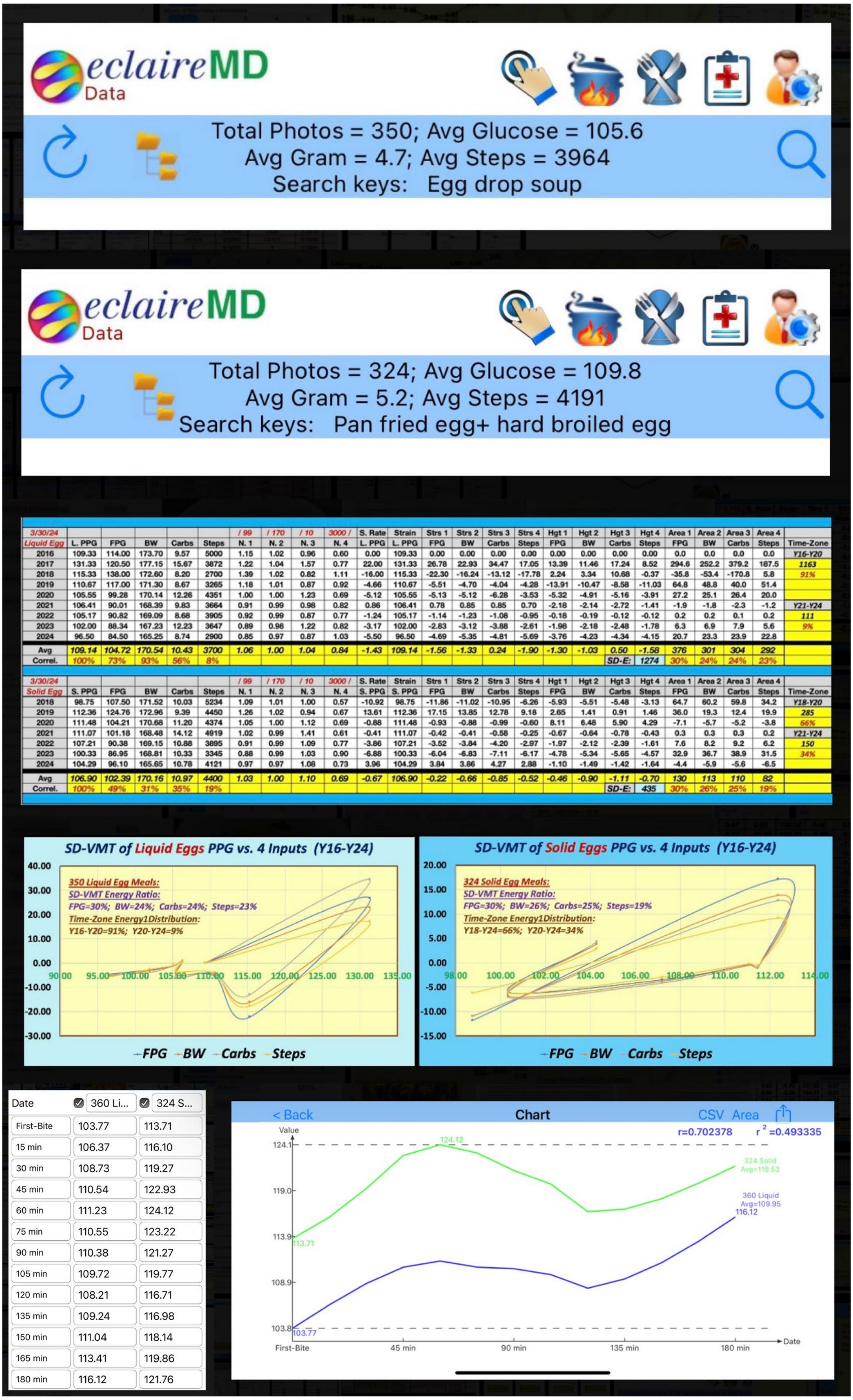
Strain rate
= (body weight at next time instant) - (body weight at present time instant)

The risk probability % of developing into CVD, CKD, Cancer is calculated based on his developed metabolism index model (MI) in 2014. His MI value is calculated using inputs of 4 chronic conditions, i.e. weight, glucose, blood pressure, and lipids; and 6 lifestyle details, i.e. diet, drinking water, exercise, sleep, stress, and daily routines. These 10 metabolism categories further contain ~500 elements with millions of input data collected and processed since 2010. For individual deadly disease risk probability %, his mathematical model contains certain specific weighting factors for simulating certain risk percentages associated with different deadly diseases, such as metabolic disorder-induced CVD, stroke, kidney failure, cancers, dementia; artery damage in heart and brain, micro-vessel damage in kidney, and immunity-related infectious diseases, such as COVID death.

Some of explored deadly diseases and longevity characteristics using the ***viscoplastic medicine theory (VMT)*** include stress relaxation, creep, hysteresis loop, and material stiffness, damping effect ***based on time-dependent stress and strain*** which are different from his previous research findings using ***linear elastic glucose theory (LEGT)*** and ***nonlinear plastic glucose theory (NPGT).***

7. Results

Figure 1 shows 350 liquid egg meals PPG and 324 solid egg meals PPG.



3/30/24						/ 99	/ 170	/ 10	3000 /	S. Rate	Strain	Strs 1	Strs 2	Strs 3	Strs 4	Hgt 1	Hgt 2	Hgt 3	Hgt 4	Area 1	Area 2	Area 3	Area 4	
Liquid Egg	L. PPG	FPG	BW	Carbs	Steps	N. 1	N. 2	N. 3	N. 4	L. PPG	L. PPG	FPG	BW	Carbs	Steps	FPG	BW	Carbs	Steps	FPG	BW	Carbs	Steps	Time-Zone
2016	109.33	114.00	173.70	9.57	5000	1.15	1.02	0.96	0.60	0.00	109.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	Y16-Y20
2017	131.33	120.50	177.15	15.67	3872	1.22	1.04	1.57	0.77	22.00	131.33	26.78	22.93	34.47	17.05	13.39	11.46	17.24	8.52	294.6	252.2	379.2	187.5	1163
2018	115.33	138.00	172.60	8.20	2700	1.39	1.02	0.82	1.11	-16.00	115.33	-22.30	-16.24	-13.12	-17.78	2.24	3.34	10.68	-0.37	-35.8	-53.4	-170.8	5.8	91%
2019	110.67	117.00	171.30	8.67	3265	1.18	1.01	0.87	0.92	-4.66	110.67	-5.51	-4.70	-4.04	-4.28	-13.91	-10.47	-8.58	-11.03	64.8	48.8	40.0	51.4	
2020	105.55	99.28	170.14	12.26	4351	1.00	1.00	1.23	0.69	-5.12	105.55	-5.13	-5.12	-6.28	-3.53	-5.32	-4.91	-5.16	-3.91	27.2	25.1	26.4	20.0	
2021	106.41	90.01	168.39	9.83	3664	0.91	0.99	0.98	0.82	0.86	106.41	0.78	0.85	0.85	0.70	-2.18	-2.14	-2.72	-1.41	-1.9	-1.8	-2.3	-1.2	Y21-Y24
2022	105.17	90.82	169.09	8.68	3905	0.92	0.99	0.87	0.77	-1.24	105.17	-1.14	-1.23	-1.08	-0.95	-0.18	-0.19	-0.12	-0.12	0.2	0.2	0.1	0.2	111
2023	102.00	88.34	167.23	12.23	3647	0.89	0.98	1.22	0.82	-3.17	102.00	-2.83	-3.12	-3.88	-2.61	-1.98	-2.18	-2.48	-1.78	6.3	6.9	7.9	5.6	9%
2024	96.50	84.50	165.25	8.74	2900	0.85	0.97	0.87	1.03	-5.50	96.50	-4.69	-5.35	-4.81	-5.69	-3.76	-4.23	-4.34	-4.15	20.7	23.3	23.9	22.8	
Avg	109.14	104.72	170.54	10.43	3700	1.06	1.00	1.04	0.84	-1.43	109.14	-1.56	-1.33	0.24	-1.90	-1.30	-1.03	0.50	-1.58	376	301	304	292	
Correl.	100%	73%	93%	56%	8%													SD-E:	1274	30%	24%	24%	23%	

3/30/24						/ 99	/ 170	/ 10	3000 /	S. Rate	Strain	Strs 1	Strs 2	Strs 3	Strs 4	Hgt 1	Hgt 2	Hgt 3	Hgt 4	Area 1	Area 2	Area 3	Area 4	
Solid Egg	S. PPG	FPG	BW	Carbs	Steps	N. 1	N. 2	N. 3	N. 4	S. PPG	S. PPG	FPG	BW	Carbs	Steps	FPG	BW	Carbs	Steps	FPG	BW	Carbs	Steps	Time-Zone
2018	98.75	107.50	171.52	10.03	5234	1.09	1.01	1.00	0.57	-10.92	98.75	-11.86	-11.02	-10.95	-6.26	-5.93	-5.51	-5.48	-3.13	64.7	60.2	59.8	34.2	Y18-Y20
2019	112.36	124.76	172.96	9.39	4450	1.26	1.02	0.94	0.67	13.61	112.36	17.15	13.85	12.78	9.18	2.65	1.41	0.91	1.46	36.0	19.3	12.4	19.9	285
2020	111.48	104.21	170.68	11.20	4374	1.05	1.00	1.12	0.69	-0.88	111.48	-0.93	-0.88	-0.99	-0.60	8.11	6.48	5.90	4.29	-7.1	-5.7	-5.2	-3.8	66%
2021	111.07	101.18	168.48	14.12	4919	1.02	0.99	1.41	0.61	-0.41	111.07	-0.42	-0.41	-0.58	-0.25	-0.67	-0.64	-0.78	-0.43	0.3	0.3	0.3	0.2	Y21-Y24
2022	107.21	90.38	169.15	10.88	3895	0.91	0.99	1.09	0.77	-3.86	107.21	-3.52	-3.84	-4.20	-2.97	-1.97	-2.12	-2.39	-1.61	7.6	8.2	9.2	6.2	150
2023	100.33	86.95	168.81	10.33	3345	0.88	0.99	1.03	0.90	-6.88	100.33	-6.04	-6.83	-7.11	-6.17	-4.78	-5.34	-5.65	-4.57	32.9	36.7	38.9	31.5	34%
2024	104.29	96.10	165.65	10.78	4121	0.97	0.97	1.08	0.73	3.96	104.29	3.84	3.86	4.27	2.88	-1.10	-1.49	-1.42	-1.64	-4.4	-5.9	-5.6	-6.5	
Avg	106.90	102.39	170.16	10.97	4400	1.03	1.00	1.10	0.69	-0.67	106.90	-0.22	-0.66	-0.85	-0.52	-0.46	-0.90	-1.11	-0.70	130	113	110	82	
Correl.	100%	49%	31%	35%	19%													SD-E:	435	30%	26%	25%	19%	

Date	360 Li...	324 S...
First-Bite	103.77	113.71
15 min	106.37	116.10
30 min	108.73	119.27
45 min	110.54	122.93
60 min	111.23	124.12
75 min	110.55	123.22
90 min	110.38	121.27
105 min	109.72	119.77
120 min	108.21	116.71
135 min	109.24	116.98
150 min	111.04	118.14
165 min	113.41	119.86
180 min	116.12	121.76

Figure 1: 350 liquid egg meals PPG and 324 solid egg meals PPG

8. Conclusions

In summary, the findings are threefold:

First, high correlations were found between liquid egg PPG versus FPG (73%) and BW (93%), while the other six correlations were lower or insignificant, highlighting ***the distinct nature of egg meals are discrete in time-domain which lack of a continuous pattern.***

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key message:

Liquid meals can significantly impact brain processing to produce lower PPG levels, beneficial for type 2 diabetes (T2D) management. Nonetheless, the pancreatic beta cells' insulin function, as indicated by FPG in early morning, remains the most influential factor. Body weight closely correlates with FPG. Carbohydrate and sugar intake is more significant than post-meal exercise, although both are important for PPG management.

References

For editing purposes, majority of the references in this paper, which are self-references, have been removed for this article. Only references from other authors' published sources remain. The bibliography of the author's original self-references can be viewed at www.eclairemd.com.

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