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The GH-Method

Viscoelastic or Viscoplastic Glucose Theory (VGT #49): Investigating the Contribution Margin of Carbs/Sugar Intake Amount and Post-Meal Walking K-Steps on PPG Formation Using 4 Validations: VGT (Viscoelasticity/Plasticity Theory), LEGT (Linear Elastic Glucose Theory), EFT (Energy Theory via Fourier Transform), Along with 8 Sub-Cellular Pathology Pathways with Sensor PPG, Carbs, and K-Steps Data from an ~4-Year Period from 5/8/18 to 3/25/2022 Based on the GH-Method: Math-Physical Medicine (No. 634)

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Note: Readers who want to get a quick overview can read the abstract, results, and graphs.

Abstract

The author was a professional engineer working in the fields of the space shuttle, naval battleships, nuclear power plant, computer hardware and software, artificial intelligence, and semiconductor chips. After retiring from his work, he initiated self-study and research on internal medicine with an emphasis on biomarker relationship exploration and disease prevention. Since 2010, he has utilized these disciplines learned from 7 different universities along with various work experiences to formulate his current medical research work during the past 13 years. One thing he has learned is that in engineering or medicine, we are frequently seeking answers, illustrations, or explanations for the relationships between the input variable (force on a structure or cause of a disease) and output variable (deformation on a structure or symptom of a disease). However, the relationships between input and output could be expressed with many different matrix formats of 1 x 1, 1 x n, m x 1, or m x n (m or n means different multiple variables). In addition to these described mathematical complications, the output resulting from one or more inputs can also become an input of another output, i.e. a symptom of certain causes can become a cause of another different symptom. This phenomenon is a complex scenario in a "chain effect". In fact, engineering and biomedical complications are fundamentally mathematical problems which correlate with many inherent physical laws or principles. Over the past 13 years, in his medical research work, he has encountered more than 100 different biomarkers with almost equal amounts of cause/input variables versus symptom/output variables. For example, food and exercise influence both body weight and glucose level, where persistent high glucose can result in diabetes. When diabetes combines with hypertension (high blood pressure) and hyperlipidemia (high blood lipids), it can cause cardiovascular diseases. Furthermore, obesity and diabetes are also linked with various kinds of cancers. These multiple sets of biomedical input versus output have been researched by the author using different tools he has learned from mathematics, physics, computer science, and engineering. Previously, he has applied signal processing techniques to separate 19 components from the combined postprandial plasma glucose (PPG) wave. He identified the carbs/sugar intake amount and post-meal exercise as the two most important contributing factors to PPG formation. Based on these findings, he then applied the theory of elasticity to develop a linear elastic glucose theory (LEGT) to predict PPG value with high prediction accuracy, using carbs/sugar grams and post-meal walking k-steps as two major input components of PPG formation. Furthermore, he took a specific PPG waveform in the time domain (TD) and applied Fourier transform technique to convert it into a waveform in the frequency domain (FD). The y-axis value in the frequency diagram indicates the magnitude of energy

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corresponding to a certain frequency component on the x-axis, while the total area underneath the frequency-energy curve is the total relative energy associated with the specific PPG wave. Recently, he has applied theories of viscoelasticity and viscoplasticity (VGT) to various biomedical problems and has written about 50 medical research papers. This VGT technique emphasizes the time-dependency characteristics of certain variables. In the medical field, most biomarkers are time-dependent since body organ cells are organic in nature and change all of the time. Incidentally, VGT can generate a stress-strain curve or cause-symptom curve, which also indicates the relative energy created during the uploading (digesting carbs/sugar) and unloading (walking exercise) process over the timespan of a PPG wave. In this article, he initially selected a dataset containing 3 biomarkers, finger-pierced PPG, carbs/sugar grams (carbs), and post-meal walking k-steps (steps) over the past 8 years from Y2015 to Y2022. He then utilized the above-mentioned three math-physical tools to calculate the contribution margin % from carbs and steps respectively, and the ratio of carbs/sugar over walking k-steps. Through these data comparisons, he hopes that he can prove the carbs contribution is indeed higher than the exercise steps contribution on the PPG formation. He has already discovered this finding from his earlier research results using both LEGT and Fourier transformed frequency energy methods. Now, he just tries to use the VGT technique to re-validate his earlier finding. He applies VGT specifically to construct a stress-strain diagram with two hysteresis loops corresponding to carbs/sugar and k-steps. The two-loop areas reflect the relative energies associated with input from carbs/sugar and k-steps respectively during the time-dependent process of uploading (digesting carbs/sugar) and downloading (walking). Finally, he lists those 8 sub-cellular pathology pathways of chronic diseases, specifically related to diabetes, from the book Metabolical written by Dr. Robert H. Lustig. The work behind this article allows him to link his math-physical results with pathological results. Here are some equations applied or developed by the author: LEGT predicted PPG = FPG*GH.f + carbs/sugar grams * GH.p - post-meal walking k-steps * GH.w, where 3 GH-modules are defined as: GH.f=0.96, GH.p= 3.43, GH.w=5.0. for his body health on metabolism. The following defined stress and strain equations are used to establish the VGT stress-strain diagram in a space domain (SD): VGT strain = ε (PPG) = individual PPG at the present time. VGT stress = σ (based on the change rate of strain, PPG, multiplying with a viscosity factor, carbs, or steps) = η * (dε/dt) = η * (d-strain/d-time) = (viscosity factor η using individual carbs or steps at present time) * (PPG at present time - PPG at a previous time). However, the measurement units for carbs/sugar (grams) and post-meal walking exercise (thousand steps or k-steps) were defined long ago without deep thought on their biomedical means in terms of their inherent biophysical inter-relationships. To place them on even ground with a sufficient biomedical sense, he has normalized the viscosity factor η of both carbs/sugar and k-steps respectively, using the following 2 formulas: Normalized carbs/sugar = carbs&sugar / 8.0; Normalized walking K-steps = walking K-steps / 4.0. In other words, his daily practice targets are to maintain an extremely low carbs/sugar consumption (8 grams) and combine high-quality proteins, vitamins, minerals, and other necessary ingredients to complement the 4,000 walking steps after each meal. To control the word size of this article, he omits the repetitive background introduction regarding LEGT, VGT, Fourier transformation, frequency domain analysis, and energy theory in the Research Methods section. However, he will include the actual data calculation and a summary description for 8 biomedical sub-cellular pathology pathways in the method section. In conclusion, by using the 4 validations, the author has obtained 4 different results. Among them, three results are extremely close to each other except the Fourier transformed energy result. In general, for all of these 4 results, the carbs/sugar contributions on PPG are definitely higher than the walking exercise contribution on PPG. Using 3 different math-physical medicine (MPM) research tools, carbs/sugar contribute 61% - 79% to PPG, and post-meal walking exercise contributes 21% - 39% to PPG. Using illustrations from the sub-cellular pathways in physiology pathology, carbs/sugar contributes 62% to PPG and post-meal walking exercise contributes 38% to PPG. These four sets of validations provide a strong link between the biomedical illustrations and math-physical engineering research methods and results.

Keywords: Viscoelastic; Viscoplastic; Carbs/sugar; Linear elastic glucose theory; Fasting plasma glucose; Postprandial plasma glucose

Abbreviations: LEGT: linear elastic glucose theory; PPG: postprandial plasma glucose; FPG: fasting plasma glucose; TD: time domain; FD: frequency domain; SD: space domain; MPM: math-physical medicine

1. INTRODUCTION

The author was a professional engineer working in the fields of the space shuttle, naval battleships, nuclear power plant, computer hardware and software, artificial intelligence, and semiconductor chips. After retiring from his work, he initiated self-study and research on internal medicine with an emphasis on biomarker relationship exploration and disease prevention. Since 2010, he has utilized these disciplines learned from 7 different universities along with various work experiences to formulate his current medical research work during the past 13 years.

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Furthermore, he took a specific PPG waveform in the time domain (TD) and applied Fourier transform technique to convert it into a waveform in the frequency domain (FD). The y-axis value in the frequency diagram indicates the magnitude of energy corresponding to a certain frequency component on the x-axis, while the total area underneath the frequency-energy curve is the total relative energy associated with the specific PPG wave.

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He applies VGT specifically to construct a stress-strain diagram with two hysteresis loops corresponding to carbs/sugar and k-steps. The two-loop areas reflect the relative energies associated with input from carbs/sugar and k-steps respectively during the time-dependent process of uploading (digesting carbs/sugar) and downloading (walking).

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Here are some equations applied or developed by the author:

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= FPG*GH.f + carbs/sugar grams * GH.p - post-meal walking K-steps * GH.w

Where 3 GH-modules are defined as: GH.f=0.96, GH.p= 3.43, GH.w=5.0. for his body health on metabolism.

The following defined stress and strain equations are used to establish the VGT stress-strain diagram in a space domain (SD):

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However, the measurement units for carbs/sugar (grams) and post-meal walking exercise (thousand steps or k-steps) were defined long ago without deep thought on their biomedical means in terms of their inherent biophysical inter-relationships. To place them on even ground with a sufficient biomedical sense, he has normalized the viscosity factor η of both carbs/sugar and k-steps respectively, using the following 2 formulas:

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In other words, his daily practice targets are to maintain an extremely low carbs/sugar consumption (8 grams) and combine high-quality proteins, vitamins, minerals, and other necessary ingredients to complement the 4,000 walking steps after each meal.

To control the word size of this article, he omits the repetitive background introduction regarding LEGT, VGT, Fourier transformation, frequency domain analysis, and energy theory in the Research Method section. However, he will include the actual data calculation and a summary description for 8 biomedical sub-cellular pathology pathways in the method section.

2. METHODS

2.1 Linear elastic glucose theory (LEGT)

His LEGT equation and data calculations are:

LEGT predicted PPG
= S.FPG*GH.f + carbs/sugar grams * GH.p - post-meal walking K-steps * GH.w
= 106.13*0.96 + 13.66*3.43 - 4.236*5.0
= 101.88 + 46.85 - 21.28
= 127.45

Where 3 GH modules are defined as: GH.f=0.96, GH.p= 3.43, GH.w=5.0. for his body health of metabolism.

His measured sensor PPG during the period from 5/8/2018 to 3/25/2022 is 125.77. Therefore, his prediction accuracy is 98.7%, and the correlation coefficient between his measure versus predicted PPG waveforms is 86%. From the LEGT analysis, the summation of carbs contribution of 46.85 mg/dL (69%) and the steps contribution of

21.28 mg/dL (31%) is 68.13 mg/dL (100%). Therefore, the ratio of contribution for carbs oversteps is 2.2 (= 46.5 / 21.28).

2.2 Viscoelasticity/plasticity glucose theory (VGT)

Through his VGT stress-strain analysis, the summation of carbs hysteresis loop area of 62 (61%) and the steps hysteresis loop area of 40 (39%) is 102 (100%). Therefore, the loop area ratio for carbs over steps is 1.6 (= 62 / 40).

2.3 Fourier transformed energy (FTE)

Through his FTE analysis, the summation of carbs energy-frequency curve area of 45,708 (79%) and the steps energy-frequency curve area of 12,393 (21%) is 58,101 (100%). Therefore, the frequency area ratio for carbs over steps is 3.7 (= 45,708 / 58,101 or 79% / 21%). Obviously, this FTE ratio is the largest one among these three energy ratio results.

2.4 Sub-cellular pathology pathways

In chapter 10 of the referenced book "Metabolical" written by Dr. Robert H. Lustig, there are 8 sub-cellular pathologies that are related to chronic diseases, particularly diabetes.

1. Glycation
2. Oxidative stress
3. Mitochondrial dysfunction
4. Insulin resistance
5. Membrane integrity
6. Inflammation
7. Epigenetics
8. Autophagy

All of these 8 physiology-pathological pathways are related to chronic diseases, and also related to each other and food. But, only 5 of them are responsive to exercise. Physical activity is a useful adjunct, but you can't outrun a bad diet.

Therefore, choosing a simple way of estimation, the ratio between food (62%) and exercise (38%) is 1.6 (= 8 / 5 or 62% / 38%).

Note: For a more detailed description, please refer to the "consolidated method" section which is given at the beginning of the special issue.

3. RESULTS

Figure 1 shows a waveform comparison of measured PPG versus predicted PPG using the LEGT equation.

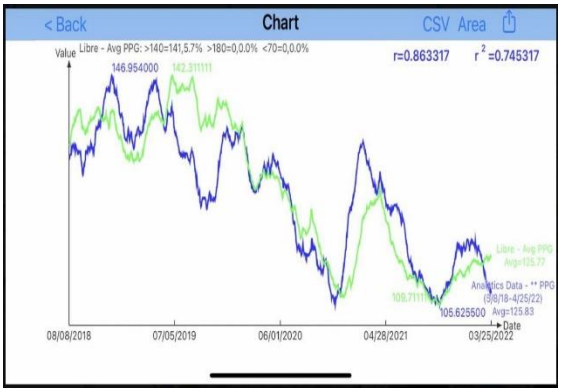

Figure 1: A waveform comparison of measured PPG versus predicted PPG using LEGT equation.

Figure 2 depicts the stress-strain diagram in the space domain of S.FPG vs. carbs/sugar and walking K-steps.

Figure 3 reflects the carbs wave and steps wave in both the time domain and frequency domain with 2 total areas of relative energy.

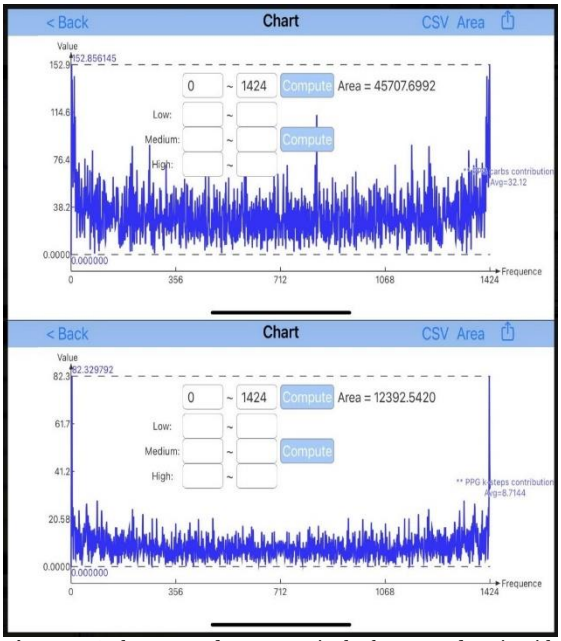

Figure 3: Carbs wave and steps wave in the frequency domain with 2 total areas of relative energy.

Figure 4 is a summarized comparison data table of 4 sets of relative energy associated with carbs and steps using 4 different methods.

3/26/22						
Contribution on PPG	Carbs/Sugar #	K-steps #	Subtotal #	Carbs/Sugar %	K-steps %	Ratio (Carbs/steps)
VGT (viscoselasticity)	62	40	102	61%	39%	1.6
LEGT (linear elasytic)	46.85	21.18	68	69%	31%	2.2
EFT (energy Fourier)	45708	12393	58101	79%	21%	3.7
8 pathology pathways	8	5	13	62%	38%	1.6

Figure 4: A summarized comparison data table of 4 relative energies associated with carbs and steps using 4 different methods.

4. CONCLUSION

In conclusion, by using the 4 validations, the author has obtained 4 different results. Among them, three results are extremely close to each other except the Fourier transformed energy result. In general, for all of these 4 results, the carbs/sugar contributions on PPG are definitely higher than the walking exercise contribution on PPG.

Using 3 different math-physical medicine (MPM) research tools, carbs/sugar contribute 61% - 79% to PPG, and post-meal walking exercise contributes 21% - 39% to PPG. Using illustrations from the sub-cellular pathways in physiology pathology, carbs/sugar contributes 62% to PPG and post-meal walking exercise contributes 38% to PPG. These four sets of validations provide a strong link between the biomedical illustrations and math-physical engineering research methods and results.

5. REFERENCES

For editing purposes, the majority of the references in this paper, which are self-references, have been removed. 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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Viscoelastic and Viscoplastic Glucose Theory Application in Medicine

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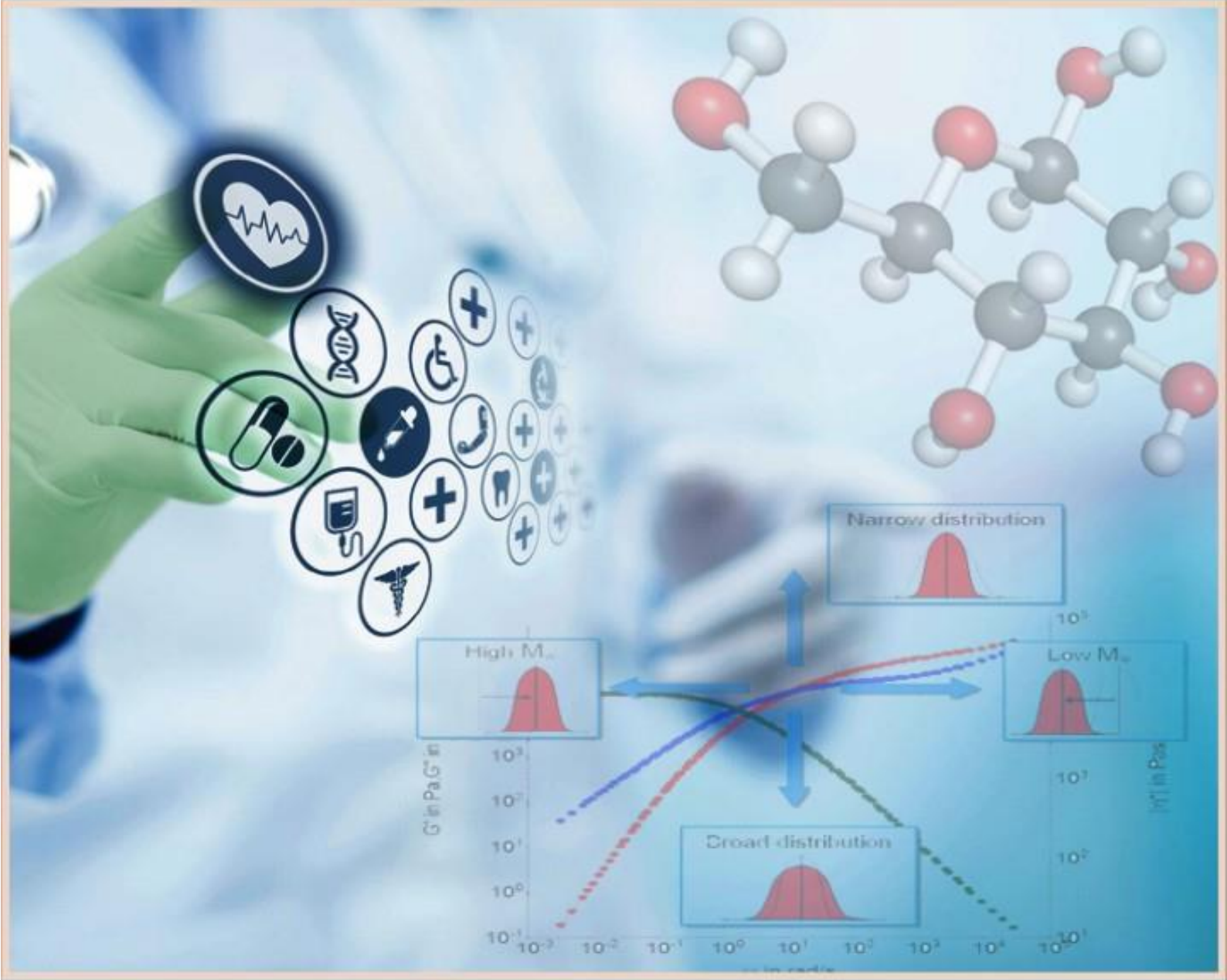

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