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Viscoelastic or Viscoplastic Glucose Theory (VGT #85): A Study on the Influences of Cardiovascular Disease Risk, Estimated Daily Average Glucose, and Body Weight from a Type 2 Diabetes Patient's Psychological Reactions and Lifestyle Changes During 9-Quarters of the COVID-19 Pandemic Period from Y2020Q1 to Y2022Q1 Based on GH-Method: Math-Physical Medicine, Especially the VGT Energy Tool (No. 675)

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Abstract

The author is a mathematician and engineer who has conducted medical research work over the past 13 years. Thus far, he has written 670 medical research papers. Beginning with paper No. 578 dated 1/8/2022, he wrote a total of 80 medical research articles using the viscoelasticity and viscoplasticity theories (VGT) from physics and engineering disciplines on 80 different medical problems with their associated data. These papers aim to explore some hidden biophysical behaviors and provide a quantitative understanding of the inter-relationships of a selected medical output (symptom) versus singular input or multiple inputs (root causes, risk factors, or influential inputs). The hidden biophysical behaviors and possible inter-relationships exist among lifestyle details, medical conditions, chronic diseases, and certain severe medical complications, such as heart attacks, stroke, cancers, dementia, and even longevity concerns. The chosen medical subjects with their associated data, multiple symptoms, and influential factors are "time-dependent" which means that all biomedical variables change from time to time because body living cells are dynamically changing. This is what Professor Norman Jones, the author's adviser at MIT, suggested to him in December 2021 and why he utilizes the VGT tools from physics and engineering to conduct his medical research work since then. During his recent medical research work using the tool of viscoelastic or viscoplastic behavior theory (VGT), he suddenly realized that there is a strong similarity between medicine and economics. The behaviors and patterns of economics variables (inputs and outputs) he observed are comparable to the behaviors and patterns of medical variables he studied and researched (causes and symptoms), in terms of their curve shape & waveforms, fluctuation patterns, and moving trends, physical behaviors, etc. For example, he has applied the candlestick chart or K-line diagram from Wall Street as an effective glucose representation tool in medicine. Most importantly, variables in both medicine and economics possessed the common "time-dependent" characteristics. The recent COVID-19 pandemic is a severe and unique experience to worldwide people that is comparable to the Spanish Flu that happened over a century ago. He wondered what type of biomedical impact or inter-relationship from this COVID pandemic had on some of his collected (eAG and BW) or calculated (CVD Risk) biomarkers. Therefore, in this article, he selects a chain of mutually influenced biomarkers of the cardiovascular disease risk % (CVD risk), estimated daily average glucose (eAG), and body weight (BW) along with the COVID-19 infection cases in the USA as the key input variable to conduct a series of inter-connected VGT analysis research work. The author conceived the idea of using mathematics, physics, and engineering in medical research while he was learning and practicing psychology approximately 20 years ago when he was conducting his charitable psychotherapy work. Due to the protection of his psychological patients' clinical data, requiring privacy and confidentiality, he decided not to use the collected data of his patients in his research work. In addition, most of the published psychological papers he has read to date are "subjective and language descriptive" rather than "objective and equation/number descriptive" like most papers on science and engineering. As a

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His paper No. 671 through No. 674 are dealing with the COVID disease using three key US economic measurements. From this economic exercise, he realized that the established theory of viscoelasticity and viscoplasticity (from the physics branch of science) should not only be limited to a smaller scope of engineering applications. Its abilities to link certain time-dependent variables and their physical characteristics, as well as their associated energy estimation via the hysteresis loop area, are equally powerful for applications in both medicine and economics. The author would like to describe the essence of the VGT in 6 simple steps using the English language instead of mathematical equations for readers who do not have an extensive academic background in engineering, physics & mathematics - an excerpt from Wikipedia is still included in the Method section of the full-text article. The first step is to collect the output data (strain or ε) on a time scale, e.g. quarterly CVD risk, eAG, and body weight. The second step is to calculate the output change rate with time (dε/dt), e.g. the change rate of CVD risk, eAG, or body weight over each quarter. The third step is to collect the input data (viscosity or η) on a time scale, e.g. quarterly numbers of COVID infections. The fourth step is to calculate the time-dependent input (time-dependent stress or σ) by multiplying dε/dt and η together. (This "time-dependent input equation" is: stress σ = strain change rate of dε/dt * viscosity η). The fifth step is to plot the input-output (i.e. stress-strain or cause-symptom) curve in a space domain (x-axis versus y-axis) with strain (output or symptom) on the x-axis; and stresses (time-dependent inputs, causes, or stresses) on the y-axis. The sixth step is to calculate the total enclosed area within these input-output curves (or hysteresis loop areas) which is also the indicator of associated energies (either created energy or dissipated energy) of this dataset of input and output. These energy values can also be considered as the degrees of influence on output by inputs. After providing this English description, he would like to use the following re-defined VGT equation from engineering and physics to address the unique "time-dependency characteristic" of engineering, economics, and medical variables. He can then establish a stress-strain diagram in a space domain (SD) where: Strain = ε = individual strain value at the present quarter. Stress = σ (based on the change rate of strain multiplying with a chosen viscosity factor η, e.g. COVID infection case) = η * (dε/dt) = η * (d-strain/d-time) = (viscosity factor η using individual viscosity factor at present quarter) * (strain at present quarter - strain at previous quarter). These inputs (causes or viscosity factors) are further normalized by dividing them by the average viscosity number or a certain established standard. This normalization process can remove the dependency of the individual unit or certain characteristics associated with each viscosity factor. This process allows him to modify these variables into a set of "dimensionless variables" for easier comparison and interpretation of results. There are 4 analyses observed in this article: (1) CVD Risk as the strain versus two stresses of eAG and COVID infection. (2) eAG as the strain versus two stresses of BW and COVID infection. (3) BW as the strain versus two stresses of Food quantity % and COVID infection. (4) CVD Risk as the strain versus three stresses of eAG, BW, and COVID infection. Cases 1 and 4 are two different VGT analyses of studying the CVD Risk % using COVID infection as the major input. However, Case 1 has a total of 2 inputs which are COVID infection and eAG, while Case 4 has a total of 3 inputs which are COVID infection, eAG, and BW. In summary, there are 4 observations from these 4 studies of CVD Risk, eAG, and BW versus COVID infection numbers: (1) From the time domain analysis of 9-recent quarters (Figure 1) the correlations are: CVD vs. eAG = -7%; CVD vs. BW = 57%; eAG vs. BW = 51%; eAG vs. Food = 54%; BW vs. Food = 65%. However, another time-domain analysis of 7-years (Figure 2) the correlations are: CVD vs. eAG = 91%; eAG vs. BW = 81%; BW vs. Food = 70%. It is obvious that the statistical correlation analysis results are heavily dependent upon the selection of numbers, characteristics, and time windows of data. Nevertheless, the following biomedical sequential effect still holds true: "Food quantity decides BW, BW influences glucose, and glucose affects CVD risk." (2) Researching the part of strains from the VGT results, we have seen that his CVD risk % fluctuated between 49% and 54%, starting at 53% in Y20Q1 and ending at 52% in Y22Q1. His eAG started at 126 mg/dL in Y20Q1 and dropped to 108 mg/dL in Y22Q1. His BW started at 171 lbs. in Y20Q1 and decreased to 169 lbs. in Y22Q1. His food quantity started at 71% of his previous normal amount in Y20Q1 and dropped to 54% of the previous normal amount in Y22Q1. Generally speaking, all of these 4 biomarkers, CVD risk %, eAG, BW, and Food quantity % are decreasing

quarter after quarter. In addition, the strain change rates (except food) determine the basic waveform patterns of these stress-strain curves. (3) Researching the stress-strain diagrams from the first 3 VGT analysis results, the 3 stress-strain waveform patterns are different from each other due to their different strain change rates. Furthermore, the magnitude difference among the three stresses decides the final shapes and areas of the 3 stress-strain curves. The combination of strain and stress components affects the actual size of the hysteresis loop area or its associated energy level, i.e. the degree of influence of the stresses on the strain. All three stress-strain curves and their respective hysteresis loop areas have shown that the COVID pandemic has indeed contributed to his 3 biomarkers, CVD Risk, eAG, and BW, with different degrees of influence. Among the 3 stress-strain diagrams, the COVID infection has generated the largest share of energy (64%) in each case. In other words, BW has the largest influence on eAG which matches his previous findings using different research methods. In comparison with the other two cases, COVID infection contributes almost half of the total share of energy (~50%) to both CVD risk and body weight cases. (4) For the fourth case of CVD Risk % versus eAG, BW, and COVID infection, the VGT study results depict that the COVID infection area of 13.2 (34%) versus eAG area of 13.0 (33%) and BW area of 13.0 (33%). For comparison purposes, in the first case of CVD Risk versus eAG and COVID infection, the VGT study results reflect the COVID infection area of 13.2 (51%) versus the eAG area of 13.0 (49%). This VGT energy tool adopted from engineering and physics can provide some interesting clues for useful interpretation of results from this particular research work of combined biomarkers and COVID infection. In conclusion, his psychological fear of getting infected by COVID has assisted him in improving his lifestyle control and medical condition maintenance.

Keywords: Viscoelastic; Viscoplastic; Cardiovascular disease; Estimated daily average glucose; Body weight; Type 2 diabetes; Lifestyle; COVID-19

Abbreviations: CVD: cardiovascular disease; BW: body weight; SD: space domain; TD: time domain; MPM: math-physical medicine

1. INTRODUCTION

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= ε
= individual strain value at the present quarter

Stress
= σ (based on the change rate of strain multiplying with a chosen viscosity factor η, e.g. COVID infection case)
= η * (dε/dt)
= η * (d-strain/d-time)
= (viscosity factor η using individual viscosity factor at present quarter) * (strain at present quarter - strain at previous quarter)

These inputs (causes or viscosity factors) are further normalized by dividing them by the average viscosity number or a certain established standard. This normalization process can remove the dependency of the individual unit or certain characteristics associated with each viscosity factor. This process allows him to modify these variables into a set of "dimensionless variables" for easier comparison and interpretation of results.

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2. METHODS

2.1 Psychological fear of COVID on lifestyle and biomarkers

Since 2010, the author has self-studied and researched the medical branches of endocrinology, chronic diseases, and their complications, including cardiovascular diseases, kidney diseases, neuropathy, retinopathy, cancers, and dementia for 13 years. Over this period, he has spent a total of around 40,000 hours reading approximately 2,500 published medical papers and collected and processed more than 3 million data from his own body and lifestyle details.

In early January of 2020, when he heard the news of SARS 2 in Wuhan, China, he immediately sensed the seriousness and danger of this virus since he escaped the SARS outbreak that occurred in 2003 when he was in China and Taiwan at that time. Therefore, on 1/19/2020 (about 3 months earlier than the US general public awareness of COVID), he decided to self-quarantine completely without venturing into any public space. For example, all of his food and basic necessities have been delivered by Amazon, Costco, UPS, etc. Eventually, with the availability of the COVID vaccine, he decided to get vaccinated and boosted, so that he can feel safe enough to attend medical appointments and regular blood draws.

Whether his concern about COVID is real or imaginary, the psychological fear has brought profound changes to his lifestyle details as well as his general health conditions. For the prior period of 2 years from 2018 to 2019, he traveled around the world to attend 63 medical conferences, delivered ~120 speeches, and met thousands of medical professionals. This heavy travel lifestyle had increased both his body weight and glucose levels. During these 2+ years of the COVID quarantine period, he has paid close attention to his food quantity (for weight and glucose), nutrition (for immunity), exercise (for weight and glucose), and sleep and stress (for both metabolism and immunity). In this way, at the same time through lifestyle management, he can simultaneously strengthen his metabolism to control his existing chronic diseases of internal organs, and his immunity to fight against the external virus to invade into his body and damaging his internal organs. His daily standards of lifestyle control became more stringent than in his pre-COVID years.

The following table lists his average lifestyle data:

Carbohydrates & sugar = 13 grams
Post-meal walking = 4,226 steps
Daily walking = 15,246 steps
Sleep hours = 7.5 hours
Food quantity = 50% of normal

As a result, his average key biomarkers data are:

Weight = 169 lbs (BMI=24.9)
eAG/FPG/PPG = 105/97/107
SBP/DBP/HR = 110/64/56
TG/HDL/LDL/TC = 110/42/116/173
CVD or Stroke risk % = 52%

As a matter of fact, his psychological fear of getting infected by COVID has actually assisted him in improving his lifestyle control and medical condition maintenance.

2.2 MPM background

To learn more about his developed GH-Method: math-physical medicine or MPM methodology, readers can select the following three articles from the 400+ published medical papers.

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

All of the listed papers in the Reference section are his written and published medical research papers.

2.3 Elasticity, plasticity, viscoelasticity, and viscoplasticity (LEGT & VGT)

The difference between elastic materials and viscoelastic materials (from "Soborthans, innovating shock and vibration solutions").

What are elastic materials?

Elasticity is the tendency of solid materials to return to their original shape after forces are applied on them. When the forces are removed, the object will return to its initial shape and size if the material is elastic.

Medical analogy: The medical application is when cause or risk factors are reduced or removed, the symptoms of certain disease would be improved or ceased.

What are viscous materials?

Viscosity is a measure of a fluid's resistance to flow. A fluid with large viscosity resists motion. A fluid with low viscosity flows. For example, water flows more easily than syrup because it has a lower viscosity. High viscosity materials might include honey, syrups, or gels – generally things that resist flow. Water is a low viscosity material, as it flows readily. Viscous materials are thick or sticky or adhesive. Since heating reduces viscosity, these materials don't flow easily. For example, warm syrup flows more easily than cold.

What is viscoelastic?

Viscoelasticity is the property of materials that exhibit both viscous and elastic characteristics when undergoing deformation. Synthetic polymers, wood, and human tissue, as well as metals at high temperature, display significant viscoelastic effects. In some applications, even a small viscoelastic response can be significant.

Medical analogy: Viscoelastic behavior means material has "time-dependent" characters. Biomedical data, i.e. biomarkers, are time-dependent due to body cells are organic which changes with time constantly.

Elastic behavior versus viscoelastic behavior

The difference between elastic materials and viscoelastic materials is that viscoelastic materials have a viscosity factor and the elastic ones don't. Because viscoelastic materials have the viscosity factor, they have a strain rate dependent on time. Purely elastic materials do not dissipate energy (heat) when a load is applied, then removed; however, a viscoelastic substance does.

Medical analogy: Most of the biomarkers display time-dependency; therefore they have both change-rate of time and viscosity factor behaviors. Viscoelastic biomarkers do dissipate energy when a cause force is applied on it.

The following brief introductions are excerpts from Wikipedia:

"Elasticity (physics):

The physical property is when materials or objects return to their original shape after deformation.

In physics and materials science, elasticity is the ability of a body to resist a distorting influence and to return to its original size and shape when that influence or force is removed. Solid objects will deform when adequate loads are applied to them; if the material is elastic, the object will return to its initial shape and size after removal. This is in contrast to plasticity, in which the object fails to do so and instead remains in its deformed state.

Hooke's law states that the force required to deform elastic objects should be directly proportional to the distance of deformation, regardless of how large that distance becomes. This is known as perfect elasticity, in which a given object will return to its original shape no matter how strongly it is deformed. This is an ideal concept only; most materials that possess elasticity in practice remain purely elastic only up to very small deformations, after which plastic (permanent) deformation occurs.

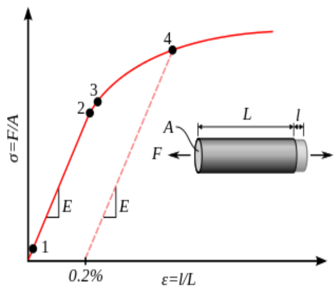
In engineering, the elasticity of a material is quantified by the elastic modulus such as the Young's modulus, bulk modulus or shear modulus which measure the amount of stress needed to achieve a unit of strain; a higher modulus indicates that the material is harder to deform. The material's elastic limit or yield strength is the maximum stress that can arise before the onset of plastic deformation.

Medical analogy: The elastic behavior analogy in medicine can be expressed by the metal rod analogy for the postprandial plasma glucose (PPG). Consuming carbohydrates and/or sugar acts like a tensile force to stretch a metal rod longer, while post-meal exercise acts like a compressive force to suppress a metal rod shorter. If lacking food consumption and exercise, the metal rod (analogy of PPG) will remain its original length, for a non-diabetes or less severe type 2 diabetes (T2D) patient.

Plasticity (physics):

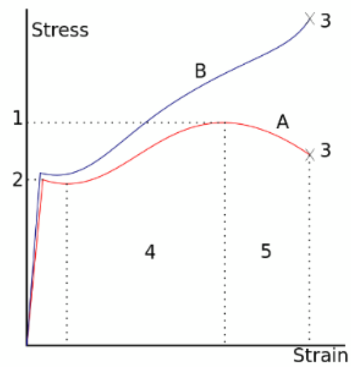
Deformation of a solid material undergoing non-reversible changes of shape in response to applied forces.

In physics and materials science, plasticity, also known as plastic deformation, is the ability of a solid material to undergo permanent deformation, a non-reversible change of shape in response to applied forces. For example, a solid piece of metal being bent or pounded into a new shape displays plasticity as permanent changes occur within the material itself. In engineering, the transition from elastic behavior to plastic behavior is known as yielding. Plastic deformation is observed in most materials, particularly metals, soils, rocks, concrete, and foams.



A stress-strain curve showing typical yield behavior for nonferrous alloys.

1. True elastic limit
2. Proportionality limit
3. Elastic limit
4. Offset yield strength



A stress-strain is typical of structural steel.

- 1: Ultimate strength
- 2: Yield strength (yield point)
- 3: Rupture
- 4: Strain hardening region
- 5: Necking region
- A: Apparent stress (F/A0)
- B: Actual stress (F/A)

For many ductile metals, tensile loading applied to a sample will cause it to behave in an elastic manner. Each increment of load is accompanied by a proportional increment in extension. When the load is removed, the piece returns to its original size. However, once the load exceeds a threshold – the yield strength – the extension increases more rapidly than in the elastic region; now when the load is removed, some degree of extension will remain.

Medical analogy: A plastic behavior analogy in medicine is the PPG level of a severe T2D patient. Even consuming a smaller amount of carbs/sugar, the patient's PPG will rise sharply which cannot be totally brought down to a healthy PPG level even with a significant amount of exercise. This means the PPG level has exceeded its "elastic limit" and entering into a "plastic range".

Viscoelasticity:

Property of materials with both viscous and elastic characteristics under deformation.

In materials science and continuum mechanics, viscoelasticity is the property of materials that exhibit both viscous and elastic characteristics when undergoing deformation. Viscous materials, like water, resist shear flow and strain linearly with time when a stress is applied. Elastic materials strain when stretched and immediately return to their original state once the stress is removed.

Viscoelastic materials have elements of both of these properties and, as such, exhibit time-dependent strain. Whereas elasticity is usually the result of bond stretching along crystallographic planes in an ordered solid, viscosity is the result of the diffusion of atoms or molecules inside an amorphous material.

In the nineteenth century, physicists such as Maxwell, Boltzmann, and Kelvin researched and experimented with creep and recovery of glasses, metals, and rubbers. Viscoelasticity was further examined in the late twentieth century when synthetic polymers were engineered and used in a variety of applications. Viscoelasticity calculations depend heavily on the viscosity variable, η. The inverse of η is also known as fluidity, φ. The value of either can be derived as a function of temperature or as a given value (i.e. for a dashpot).

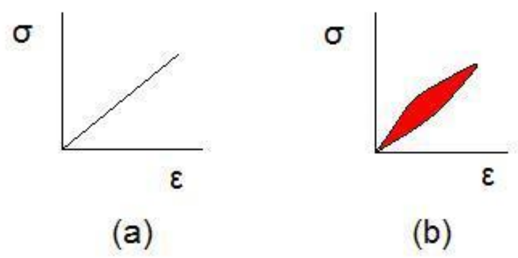
Depending on the change of strain rate versus stress inside a material, the viscosity can be categorized as having a linear, non-linear, or plastic response. In addition, when the stress is independent of this strain rate, the material exhibits plastic deformation. Many viscoelastic materials exhibit rubber-like behaviors explained by the thermodynamic theory of polymer elasticity.

Cracking occurs when the strain is applied quickly and outside of the elastic limit. Ligaments and tendons are viscoelastic, so the extent of the potential damage to them depends both on the rate of the change of their length as well as on the force applied.

A viscoelastic material has the following properties:

- hysteresis is seen in the stress-strain
- stress relaxation occurs: step constant strain causes decreasing stress
- creep occurs: step constant stress causes increasing strain
- its stiffness depends on the strain rate or the stress rate.

Elastic versus viscoelastic behavior:



Stress-strain curves for a purely elastic material (a) and a viscoelastic material (b). The red area is a hysteresis loop and shows the amount of energy lost (as heat) in a loading and unloading cycle. It is equal to $\oint \sigma d\varepsilon$ where σ is stress and ε is strain. In other words, the hysteresis loop area represents the amount of energy during the loading and unloading process.

Unlike purely elastic substances, a viscoelastic substance has an elastic component and a viscous component. The viscosity of a viscoelastic substance gives the substance a strain rate dependence on time. Purely elastic materials do not dissipate energy (heat) when a load is applied, then removed. However, a viscoelastic substance dissipates energy when a load is applied, then removed. Hysteresis is observed in the stress-strain curve, with the area of the loop being equal to the energy lost during the loading cycle. Since viscosity is the resistance to thermally activated plastic deformation, a viscous material will lose energy through a loading cycle. Plastic deformation results in lost energy, which is uncharacteristic of a purely elastic material's reaction to a loading cycle.

Viscoplasticity:

Viscoplasticity is a theory in continuum mechanics that describes the rate-dependent inelastic behavior of solids. Rate-dependence in this context means that the deformation of the material depends on the rate at which loads are applied. The inelastic behavior that is the subject of viscoplasticity is plastic deformation which means that the material undergoes unrecoverable deformations when a load level is reached. Rate-dependent plasticity is important for transient plasticity calculations. The main difference between rate-independent plastic and viscoplastic material models is that the latter exhibit not only permanent deformations after the application of loads but continue to undergo a creep flow as a function of time under the influence of the applied load.

Medical analogy: In viscoelastic or viscoplastic analysis, the stress component equals the strain change rate of time multiplying with the viscosity factor, or

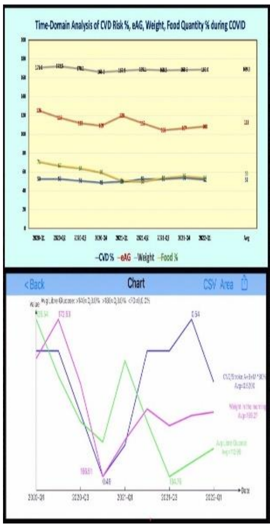
Stress (σ)
= strain (ε) change rate * viscosity factor (η)
= $d\varepsilon/dt * \eta$

The hysteresis loop area
= the integrated area of stress (σ) and strain (ε) curve
= $\oint \sigma d\varepsilon$

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 the time-domain analysis results of CVD Risk %, eAG, BW, and food quantity with multiple correlations during 9-quarters.



TD - R	CVD %	eAG	Weight	Food %
2020-Q1	53	126	171.0	71
2020-Q2	53	118	172.5	67
2020-Q3	51	112	170.1	64
2020-Q4	49	109	166.5	60
2021-Q1	50	120	167.9	51
2021-Q2	53	112	169.1	50
2021-Q3	53	105	168.5	54
2021-Q4	54	107	168.9	56
2022-Q1	52	108	169.0	54
Avg	52	113	169.3	59
R	100%	-7%	57%	8%
R	-7%	100%	51%	54%
R	57%	51%	100%	65%
R	8%	54%	65%	100%

Figure 1: Time-domain analysis results of CVD Risk %, eAG, BW, and food quantity with multiple correlations during 9-quarters.

Figure 2 displays the time-domain analysis results of CVD Risk %, eAG, BW, and food quantity with multiple correlations for 7 years.

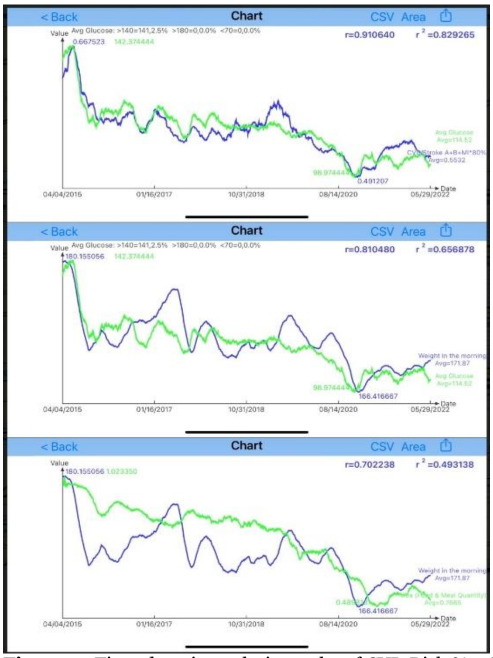


Figure 2: Time-domain analysis results of CVD Risk %, eAG, BW, and food quantity with 3 correlations for 7 years.

Figure 3 reflects data tables of 3 VGT analysis cases.

5/29/22				Infection		Norm=/Avg.	Norm=/Avg.	Strain	Stress 1	Stress2	Height	Height	Area	Area
	CVD %	CVD Rate	eAG	COVID	CVD Rate	Norm. eAG	Norm. COVID	CVD	Stress (eAG)	Stress (COVID)	eAG	COVID	eAG	COVID
Y20Q1	53	0.0	126	0	0.0	1.11	0.00	53	0.00	0.00	0.00	0.00	0.00	0.00
Y20Q2	53	0.0	118	2	0.0	1.04	0.26	53	0.00	0.00	0.00	0.00	0.00	0.00
Y20Q3	51	-2.0	112	7	-2.0	0.99	0.90	51	-1.98	-1.80	-0.99	-0.90	1.98	1.80
Y20Q4	49	-2.0	109	11	-2.0	0.97	1.41	49	-1.94	-2.83	-1.96	-2.31	3.92	4.63
Y21Q1	50	1.0	120	11	1.0	1.06	1.41	50	1.06	1.41	-0.44	-0.71	-0.44	-0.71
Y21Q2	53	3.0	112	3	3.0	0.99	0.39	53	2.97	1.16	2.02	1.29	6.06	3.86
Y21Q3	53	0.0	105	8	0.0	0.93	1.03	53	0.00	0.00	1.49	0.58	0.00	0.00
Y21Q4	54	1.0	107	11	1.0	0.94	1.41	54	0.94	1.41	0.47	0.71	0.47	0.71
Y22Q1	52	-2.0	108	17	-2.0	0.96	2.19	52	-1.92	-4.37	-0.49	-1.48	0.98	2.96
Average	52	-0.1	113	7.8	-0.1	1.0	1.0	52	-0.1	-0.6	0.0	-0.3	13.0	13.2
Sum				70								Area Ratio	49%	51%

5/29/22			Weight	Infection		Norm=/Avg.	Norm=/Avg.	Strain	Stress 1	Stress2	Height	Height	Area	Area
	eAG	eAG Rate	BW	COVID	eAG Rate	Norm. BW	Norm. COVID	eAG	Stress (BW)	Stress (COVID)	BW	COVID	BW	COVID
Y20Q1	126	0.00	171	0	0.00	1.01	0.00	126	0.00	0.00	0.00	0.00	0.00	0.00
Y20Q2	118	-7.49	173	2	-7.49	1.02	0.26	118	-7.63	-1.93	-3.82	-0.96	28.59	7.21
Y20Q3	112	-6.03	170	7	-6.03	1.00	0.90	112	-6.06	-5.43	-6.85	-3.68	41.28	22.17
Y20Q4	109	-2.69	167	11	-2.69	0.98	1.41	109	-2.65	-3.80	-4.35	-4.62	11.71	12.42
Y21Q1	120	10.73	168	11	10.73	0.99	1.41	120	10.64	15.18	4.00	5.69	42.91	61.00
Y21Q2	112	-8.04	169	3	-8.04	1.00	0.39	112	-8.03	-3.10	1.31	6.04	-10.50	-48.54
Y21Q3	105	-7.26	168	8	-7.26	1.00	1.03	105	-7.23	-7.47	-7.63	-5.28	55.38	38.36
Y21Q4	107	1.88	169	11	1.88	1.00	1.41	107	1.88	2.66	-2.67	-2.40	-5.03	-4.52
Y22Q1	108	1.84	169	17	1.84	1.00	2.19	108	1.84	4.02	1.86	3.34	3.42	6.15
Average	113	-1.90	169	7.8	-1.90	1.00	1.00	113	-1.92	0.01	-2.02	-0.21	168	94
Sum				70								Area Ratio	64%	36%

5/29/22			Quantity	Infection		Norm=/Avg.	Norm=/Avg.	Strain	Stress 1	Stress2	Height	Height	Area	Area
	BW	BW rate	Food	COVID	BW rate	Norm. Food	Norm. COVID	BW	Stress (Food)	Stress (COVID)	Food	COVID	Food	COVID
Y20Q1	171	0.0	71	0	0.0	1.21	0.00	171	0.00	0.00	0.00	0.00	0.00	0.00
Y20Q2	173	1.5	67	2	1.5	1.14	0.26	173	1.72	0.39	0.86	0.19	1.29	0.29
Y20Q3	170	-2.5	64	7	-2.5	1.09	0.90	170	-2.70	-2.22	-0.49	-0.92	1.21	2.27
Y20Q4	167	-3.6	60	11	-3.6	1.02	1.41	167	-3.64	-5.02	-3.17	-3.62	11.25	12.86
Y21Q1	168	1.4	51	11	1.4	0.87	1.41	168	1.22	1.98	-1.21	-1.52	-1.69	-2.13
Y21Q2	169	1.2	50	3	1.2	0.85	0.39	169	1.02	0.46	1.12	1.22	1.33	1.45
Y21Q3	168	-0.6	54	8	-0.6	0.92	1.03	168	-0.59	-0.66	0.21	-0.10	-0.14	0.06
Y21Q4	169	0.4	56	11	0.4	0.96	1.41	169	0.37	0.55	-0.11	-0.05	-0.04	-0.02
Y22Q1	169	0.1	54	17	0.1	0.92	2.19	169	0.12	0.28	0.25	0.42	0.03	0.05
Average	169	-0.2	59	7.8	-0.2	1.00	1.00	169	-0.28	-0.47	-0.28	-0.49	13.2	14.8
Sum				70								Area Ratio	47%	53%

Figure 3: Data tables of 3 VGT analysis cases.

Figure 4 depicts three VGT stress-strain analysis results of 3 biomarkers due to COVID infection.

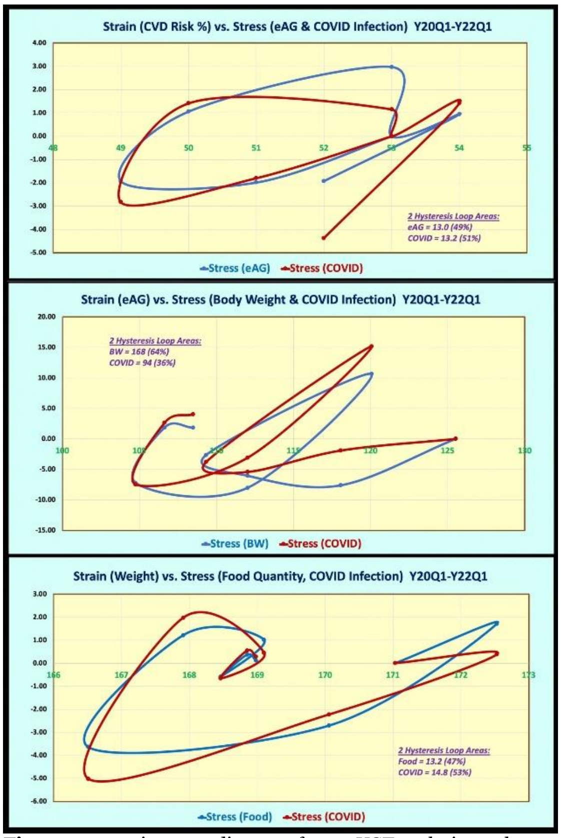
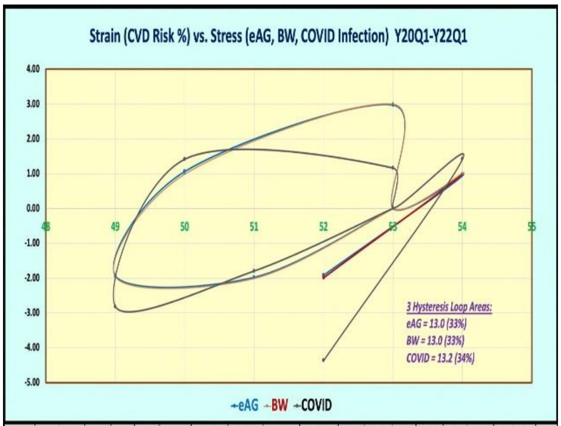


Figure 4: 3 strain-stress diagrams from 3 VGT analysis results.

Figure 5 illustrates a strain-stress diagram and data table from CVD Risk versus eAG, BW, and Food quantity.



5/29/22					Infection		Norm.=/Avg.	Norm.=/Avg.	Norm.=/Avg.	Strain	Stress 1	Stress 2	Stress 3	Height	Height	Height	Area	Area	Area
	CVD %	CVD Rate	eAG	BW	COVID	CVD Rate	Norm. eAG	Norm. BW	Norm. COVID	CVD %	eAG	BW	COVID	eAG	BW	COVID	eAG	BW	COVID
Y20Q1	53	0.0	126	171	0	0	1.11	1.01	0.00	53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y20Q2	53	0.0	118	173	2	0	1.04	1.02	0.26	53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y20Q3	51	-2.0	112	170	7	-2	0.99	1.00	0.90	51	-1.98	-2.01	-1.80	-0.99	-1.00	-0.90	1.98	2.01	1.80
Y20Q4	49	-2.0	109	167	11	-2	0.97	0.98	1.41	49	-1.94	-1.97	-2.83	-1.96	-1.99	-2.31	3.92	3.98	4.63
Y21Q1	50	1.0	120	168	11	1	1.06	0.99	1.41	50	1.06	0.99	1.41	-0.44	-0.49	-0.71	-0.44	-0.49	-0.71
Y21Q2	53	3.0	112	169	3	3	0.99	1.00	0.39	53	2.97	3.00	1.16	2.02	1.99	1.29	6.06	5.98	3.86
Y21Q3	53	0.0	105	168	8	0	0.93	1.00	1.03	53	0.00	0.00	0.00	1.49	1.50	0.58	0.00	0.00	0.00
Y21Q4	54	1.0	107	169	11	1	0.94	1.00	1.41	54	0.94	1.00	1.41	0.47	0.50	0.71	0.47	0.50	0.71
Y22Q1	52	-2.0	108	169	17	-2	0.96	1.00	2.19	52	-1.92	-2.00	-4.37	-0.49	-0.50	-1.48	0.98	1.00	2.96
Average	52	-0.1	113	169	7.8	-0.11	1.00	1.00	1.00	52.00	-0.10	-0.11	-0.56	0.01	0.00	-0.31	13.0	13.0	13.2
Sum					70											Area Ratio	33%	33%	34%

Figure 5: A strain-stress diagram and data table from CVD Risk versus eAG, BW, and food quantity.

4. CONCLUSION

In summary, there are 4 observations from these 4 studies of CVD Risk, eAG, and BW versus COVID infection numbers:

(1) From the time domain analysis of 9-recent quarters (Figure 1) the correlations are: CVD vs. eAG = -7%; CVD vs. BW = 57%; eAG vs. BW = 51%; eAG vs. Food = 54%; BW vs. Food = 65%. However, another time-domain analysis of 7-years (Figure 2) the correlations are: CVD vs. eAG = 91%; eAG vs. BW = 81%; BW vs. Food = 70%. It is obvious that the statistical correlation analysis results are heavily dependent upon the selection of numbers, characteristics, and time windows of data. Nevertheless, the following biomedical sequential effect still holds true: "Food quantity decides BW, BW influences glucose, and glucose affects CVD risk."

(2) Researching the part of strains from the VGT results, we have seen that his CVD risk % fluctuated between 49% and 54%, starting at 53% in Y20Q1 and ending at 52% in Y22Q1. His eAG started at 126 mg/dL in Y20Q1 and dropped to 108 mg/dL in Y22Q1. His BW started at 171 lbs. in Y20Q1 and decreased to 169 lbs. in Y22Q1. His food quantity started at 71% of his previous normal amount in Y20Q1 and dropped to 54% of the previous normal amount in Y22Q1. Generally speaking, all of these 4 biomarkers, CVD risk %, eAG, BW, and Food quantity % are decreasing quarter after quarter. In addition, the strain change rates (except food) determine the basic waveform patterns of these stress-strain curves.

(3) Researching the stress-strain diagrams from the first 3 VGT analysis results, the 3 stress-strain waveform patterns are different from each other due to their different strain change rates. Furthermore, the magnitude difference among the three stresses decides the final shapes and areas of the 3 stress-strain curves. The combination of strain and stress components affects the actual size of the hysteresis loop area or its associated energy level, i.e. the degree of influence of the stresses on the strain. All three stress-strain curves and their respective hysteresis loop areas have shown that the COVID pandemic has indeed contributed to his 3 biomarkers, CVD Risk, eAG, and BW, with different degrees of influence. Among the 3 stress-strain diagrams, the COVID infection has generated the largest share of energy (64%) in each case. In other words, BW has the largest influence on eAG which matches his previous findings using different research methods. In comparison with the other two cases, COVID infection contributes almost half of the total share of energy (~50%) to both CVD risk and body weight cases.

(4) For the fourth case of CVD Risk % versus eAG, BW, and COVID infection, the VGT study results depict that the COVID infection area of 13.2 (34%) versus eAG area of 13.0 (33%) and BW area of 13.0 (33%). For comparison purposes, in the first case of CVD Risk versus eAG and COVID infection, the VGT study results reflect the COVID infection area of 13.2 (51%) versus the eAG area of 13.0 (49%).

This VGT energy tool adopted from engineering and physics can provide some interesting clues for useful interpretation of results from this particular research work of combined biomarkers and COVID infection. In conclusion, his psychological fear of getting infected by COVID has assisted him in improving his lifestyle control and medical condition maintenance.

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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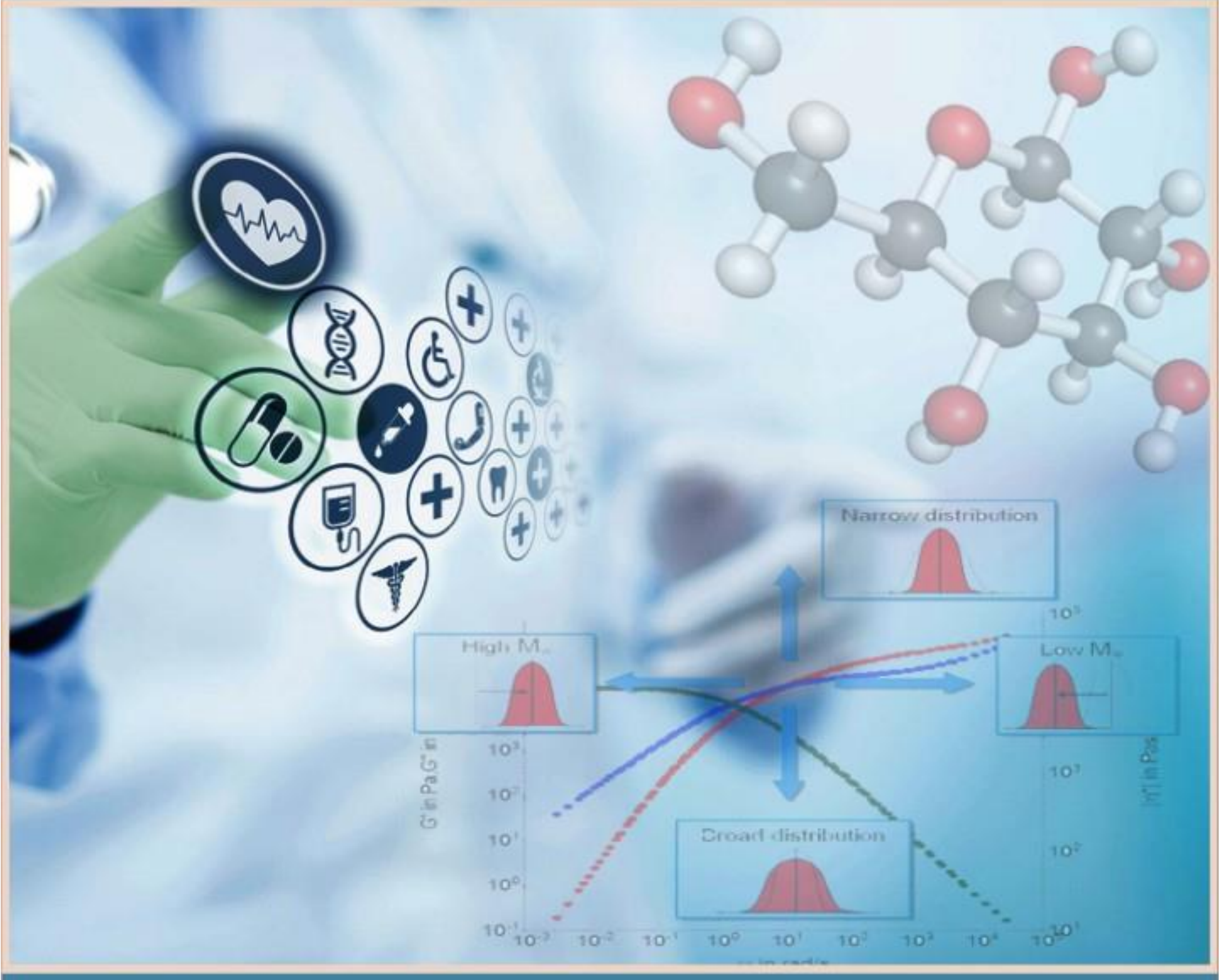

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