The GH-Method

Viscoelastic or Viscoplastic Glucose Theory (VGT #73): A Study on a Chain-Effect of Multiple Causes versus Single Symptom Starting with Lifestyle Through Diabetes, Cardiovascular Disease, and Cancers to Longevity Using a Type 2 Diabetes Patient's Collected Data of Lifestyle and Biomarkers by Applying the VGT Energy Tool from Physics and Engineering Based on GH-Method: Math-Physical Medicine (No. 663)

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Note: Readers who want to get a quick overview of this article can read the introduction, results, and conclusion section.

Abstract

The author focuses on investigating the relationships between biomedical causes and symptoms. In the medical field, it is clear that some symptoms can turn into causes for other symptoms as explained by the "m by n" matrix model in the Method Section. To date, he has applied viscoelasticity and viscoplasticity from engineering and physics to his medical research work with 72 written papers. However, most of his VGT studies are (1 x n) matrix, which is a single symptom corresponding to multiple causes. Here, he attempts to develop a "chain-effect" study of four sets of (1 x n) studies, from postprandial plasma glucose (PPG) through estimated average glucose (eAG) and cardiovascular disease (CVD) to the final estimated health age (geriatrics). The first set is PPG vs. carbs & steps, the second set is eAG vs. FPG & PPG, the third set is CVD risk vs. obesity & type 2 diabetes (T2D), and the fourth set is health age (longevity) vs. cancers risk & CVD risk. After conducting four individual VGT analyses, he further investigates a combined VGT study of longevity vs. obesity, CVD, T2D, and cancer (a 1 x 4 model). Since December 2021, the author has written and published ~70 articles using the viscoelasticity and viscoplasticity theories (VGT) from physics and engineering disciplines on chosen medical subjects. These papers aim to explore some hidden biophysical behaviors and provide a quantitative understanding of inter-relationships between a selected symptom biomarker and a few intermediate steps that include a variety of selected multiple influential factors, "causes", or "risk factors". The hidden biophysical behaviors and possible inter-relationships between diseases, complications, or longevity, and selected different sets of multiple risk factors are "time-dependent" which means that all of these variables are changing from time to time. This is why he utilizes VGT from physics and engineering to conduct his medical research work. His research of various biomarkers starts with fasting plasma glucose (FPG). FPG not only reveals many key facts regarding human health, such as pancreatic beta cells, but it also serves as the baseline of PPG. After knowing the PPG baseline level from FPG, the influences from both carbs/sugar intake amount (a "plus" effect) and post-meal walking steps of exercise (a "minus" effect) then enter into the equation to form the ultimate PPG level. After combining FPG and PPG, the HbA1C level can be determined. If hyperglycemic (high glucose level) conditions last for a long period, diabetes will develop. Eventually, diabetes will damage many internal organs of the human body which may result in many complications, such as CVD, stroke, chronic kidney disease (CKD), diabetic retinopathy (DR), neuropathy, foot ulcer, bladder infection, hypothyroidism, even diabetic constipation, and diabetic skin fungal infection. The research work behind his 70+ VGT papers since December of 2021 is similar to his school days of doing similar homework 70 times on the same subject. Every homework exercise increases his understanding level of VGT application to biomedical problems a little bit more. After accumulating these learned facts step-by-step, he has then finally developed a detailed understanding of the overview of VGT application in medicine. In the medical field, a symptom can turn into a cause of another symptom. This paper

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aims to explore some hidden biophysical behaviors which provide a quantitative sense of the inter-relationships between one symptom versus selected major influential factors or risk factors. Carbohydrates and sugar intake amounts increase PPG while post-meal walking steps decrease PPG. Hooke's law is applied to his predicted PPG equation, which he named the linear elastic glucose theory (LEGT): Predicted PPG = (FPG * GH.f) + (carbs * GH.p) - (k-steps * GH.w). Using a rigid rod member of a truss frame structure as a medical analogy. The truss member rod can only sustain the axial force, not the bending force. The tensile force is similar to the carbs/sugar FFT on PPG value while the compressive force is similar to the post-meal exercise on PPG value. The PPG's baseline, the FPG value, is similar to the inherent strength of the truss member rod. These three components constitute the final PPG value under stresses as described by the following equation: Predicted PPG = Original strength + tensile deformation - compressive deformation = FPG * GH.f + carbs/sugar amount * GH.p - post-meal walking steps* GH.w, where GH.x modulus is similar to Young's modulus in the theory of elasticity, for this medical analogy case: GH.f = 0.9; GH.p = 2.0; GH.w = 5.0. The estimated daily average glucose (eAG) is a linear combination of both FPG and PPG for the finger-pierced glucose case: eAG = FPG * 0.25 + PPG * 0.75. Using the eAG value over a 90-120 days period with a simple conversion factor (around 16-18), we can estimate a highly accurate HbA1C value at the end of a quarter. HbA1C value indicates the severity of diabetes conditions. For this study, he adopts 120 mg/dL for eAG and 6.0% for A1C as the dividing line between healthy and unhealthy diabetes conditions. Bodyweight determines the conditions of normal (BMI<25), overweight (BMI between 25 and 30), and obesity (BMI>30). Many research reports have already reported the close relationship between obesity and most medical complications, including diabetes, CVD, CKD, and a variety of cancers. Bodyweight can be a symptom of various diseases, such as obesity, fatty liver, and others. Many different types of cancer have identified being overweight or obese as one of the key risk factors. It is observed that almost all symptoms and their risk factors are "time-dependent" which means that the variables are changing from time to time. This is due to body cells changing constantly. That is why he utilizes VGT from physics and engineering to conduct his medical research work. The following defined VGT equations are used to establish a generic stress-strain diagram in a space domain (SD): Strain = ε (symptom) = individual symptom value at the present time. Stress = σ (based on the change rate of strain, or symptom rate, multiplying with a chosen viscosity factor) = η * (dε/dt) = η * (d-strain/d-time) = (viscosity factor η using individual cause at present time) * (cause at present time - cause at a previous time). Most causes (use engineering term, viscosity factors) use normalized values to remove their association with different units which would enlarge or shrink the magnitude of stress values. This would make the interpretation and comparison of the result more difficult. A few medical examples are listed showing the normalized values as the dividing line between healthy and unhealthy conditions. Normalized BMI = BMI / 25; Normalized body temperature = BT / 98; Normalized glucose = Glucose / 120; Normalized A1C = A1C / 6.0. In the VGT energy analysis, he then calculates the respective hysteresis loop areas associated with various components of stress (via trapezoid formula) to judge the energy levels associated with each viscosity factor or cause. Furthermore, he can use the stress and strain data to develop a pseudo-perturbation model for his predicted symptom: Predicted Symptom = strain value + stress value = Symptom + (d-Symptom/d-time) * (normalized Cause). The author defines the effective health age as follows as shown in Papers No. 157, 313, 323, 466, 501, and 594: Health Age = Real Biological Age * (1+((MI-0.735)/0.735)/Amplification factor). He calculates the "age difference" using the following formula: Age difference = health age - real biological. If your age difference is a positive value, then it means you are older than your real age due to poorer health and vice versa. With the 4 individual VGT analyses results, he observes the following 3 clear conclusions in Figure 2: (1) Looking into the x-axes of 4 individual stress-strain diagrams, all of their strain values (i.e. symptoms) are improving year after year. (2) The hysteresis loop areas of the first 4 years (from Y2012 to Y2015) versus the recent 7 years (from Y2016 to Y2022) are 79%-97% versus 3% to 21%. This indicates that his earlier 4 years have contributed much more energy to his body health than his recent 7 years. (3) In these 4 individual VGT analyses, each diagram has one symptom with two selected causes. The energy ratios between the first cause versus the second cause are 41% to 49% versus 51% to 59% (about a 50/50 split). This indicates that the two causes contribute almost equal amounts of energy to the symptom. This phenomenon resulted from the normalization process of all viscosity factors. Figure 4 demonstrated the combined "chain-effect" of one symptom for longevity through health age versus 4 selected causes of disease: CVD (No. 1 cause of death), cancers (No. 2), diabetes (No. 8), and obesity, which is a common risk factor for many complications and deaths. Although the author can select a different set or add more causes for longevity research, the purpose of this study is to demonstrate the chain application using a VGT tool. Therefore, he chose carbs and exercise contribution to glucose, from diabetes and heart attacks, then combined CVD with cancers, diabetes, and obesity to study the patient's reduced expected lifespan. The key observation in Figure 4 is that the calculated 4 loop areas are Cancers at 17%, T2D at 21%, CVD at 25%, and Obesity at 37%. (1) The MI-based cancer risk

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contribution is relatively lower than the MI-based CVD risk contribution over the past 11 years. This finding is a result of the first fact that he has no signs of cancer thus far and the second fact that he has already suffered 5 heart episodes 5 in the past. The result of cancers versus CVD explained why his cancer energy area is the smallest one and the CVD energy area is larger than the Caner energy. (2) His Diabetes (T2D) energy is the second smallest one due to stringent lifestyle management and persistent glucose improvement over the past 11 years. This can be proven via his 280 mg/dL in 2010 (A1C 10%) and 106 mg/dL in 2022 (A1C 5.8%). (3) The obesity (bodyweight) condition changes can be seen from his BMI of 32 in 2010 to a BMI of 25 in 2010, and then to his BMI of 24.9 in 2022. Over the past 11 years, his BMI values have been mostly above 25. The normalization process puts his bodyweight stress values around 1.0 or higher which is higher than other normalized viscosity factors. This explains why obesity contributes the highest energy to the longevity symptom. This further indicates the importance of weight control in terms of overall health maintenance. In summary, the VGT energy tool can be applied to the individual analysis and the combined chain analysis of carbs/steps to PPG, eAG (T2D), CVD, and longevity. If other medical research scientists utilize this math-physical medicine (MPM) methodology, such as LEGT or VGT tools, they can obtain a statistical analysis based on multiple patients' data first, then assemble them with the author's MPM analysis results. This combined approach can then summarize the MPM results into a wider-view statistical conclusion with a more rigorous and solid math-physical information as the foundation support.

Keywords: Viscoelastic; Viscoplastic; Cardiovascular disease; Chronic kidney disease; Cancer; Type 2 diabetes; Glucose; Blood pressure; Blood lipids; Fasting plasma glucose; Postprandial plasma glucose

Abbreviations: eAG: estimated average glucose; CVD: cardiovascular disease; CKD: chronic kidney disease; LD: lifestyle details; MC: medical conditions; T2D: type 2 diabetes; LEGT: linear elastic glucose theory; SD: space domain; TD: time domain; PPG: postprandial plasma glucose; FPG: fasting plasma glucose; MPM: math-physical medicine

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1. INTRODUCTION

Both universe (outer space) and the human body (inner space) are amazing systems that have some similarities. All of the biomarkers detected from a human body are interconnected which is similar to the inter-connected planets in outer space. As a result, the author applied the concept of the theory of relativity and combined it with the frequency domain analysis in his biomedical research work for energy estimation.

For a decade, from the mid-70s to mid-80s, the author worked on the design of navy battleship, space shuttle, and nuclear power plant. He has learned that the normal load, shear load, torsion load, and thermal effect create different types of stresses on the structure. By combining different deformations caused by different stresses, a total picture of structural deformation can be observed, estimated, and studied. Furthermore, by combining the normal wearing and tearing situations and strong impact loads from a missile, tsunami, or earthquake, the expected lifespan of the structure (either battleship or nuclear power plant) can be easily estimated. This engineering scenario is similar to the biomedical situations that which carbs/sugar and exercise have influences on postprandial plasma glucose (PPG) levels, By combining PPG with fasting plasma glucose (FPG) together, we can judge the severity of type 2 diabetes. By combining diabetes and obesity, we can have a good picture of the risk probability of developing CVD. Finally, by knowing a patient's CVD risk % (No.1 cause of death in the US), cancer risk % (No. 2), diabetes severity (No. 8), and obesity situation, we can easily estimate the expected lifespan of a patient. This is an engineer's view of biomedical problems.

In this article, the author investigates the relationships among multiple causes and symptoms. It is clear that, in the medical field, some symptoms can turn into causes for other symptoms as explained in his (m by n) or (m x n) matrix model in the Method Section. Thus far, he has applied viscoelasticity or viscoplasticity from engineering and physics to his medical research work and 72 medical papers. However, most of the previous studies are (1 x n) matrix, i.e. a single symptom corresponding to multiple causes.

In this article, he attempts to develop a "chain-effect" of four sets of 1 x n studies, from PPG through type 2 Diabetes (T2D or eAG) and CVD risk to a final estimated health age (a geriatrics subject). The first set is PPG vs. carbs & steps, the second set is eAG vs. FPG & PPG, the third set is CVD risk vs. obesity & T2D, and the fourth set is health age (longevity) vs. cancers risk & CVD risk. After conducting four individual VGT analyses, he further investigated a combined study of longevity vs. obesity, CVD, T2D, and cancer (a 1 x 4 model).

When the author faced the possibility of death from kidney failure in 2010, he woke up and decided to self-study and research every identified complication he has suffered when he became a T2D patient in 1995. His motivation was simple which is to save his own life starting at the most fundamental level and not depending on medical treatment. As a practical engineer, he always believes that "prevention is always better than treatment". During the initial period of 2010-2013, he self-studied internal medicine and food nutrition by reading a few medical textbooks and numerous published medical papers. Thus far, he has read more than 2,500 medical papers. He developed a mathematical model of metabolism in 2014 and initiated his glucose and diabetes research in 2015. In December 2017, he attended the World Health Organization (WHO) sponsored bi-annual international diabetes conference in Abu Dhabi and presented his published paper. Since 2018, he has extended his research work into multiple metabolic-disorder-related complications, such as chronic heart disease, stroke, chronic kidney disease (CKD), retinopathy, neuropathy, dementia, and cancers.

Beginning in 2012, he started to collect his body weight and finger-piercing glucose data every day. However, only after May of 2015, he accumulates more complete sets of data on his biomarkers and lifestyle details. Before that time, the data he used in this study are his best-guessed numbers based on sparsely collected data. His calculated risk probability of having both CVD and cancers is based on the developed metabolism index (MI) model which is explained in the Method section. Of

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course, before 2015, his risk probability % of developing CVD and cancers is also based on best-guessed MI scores calculated by sparsely collected data.

Since 2015, he also gathered other medical condition-related biomarker data, including a combination of blood pressure (BP), heart rate (HR), and blood lipid data (HDL, LDL, triglycerides, and total cholesterol) along with important lifestyle details (LD). Based on the collected big data, he further organized them into two main groups. The first is the medical conditions group (MC) with 4 chronic disease-related categories: weight, glucose, BP, and blood lipids. The second is the LD group with 6 root-cause and lifestyle-related categories: food & diet, exercise, water intake, sleep, stress, and daily life routine. As of 1/1/2015, he calculated a unique combined daily score for the 10 categories within the MC and LD groups. The combined scores of the 2 groups, 10 categories, and 500+ detailed elements constitute an overall "MI" value. This MI model was developed using topology, nonlinear algebra, geometric algebra, and the engineering finite element method. It includes the root causes of 6 major lifestyle inputs and symptoms of 4 rudimentary chronic diseases: obesity, diabetes, hypertension, and hyperlipidemia. Therefore, it can serve as the foundation and building block for his additional research work that can expand into various diseases associated with different organs, including CVD and stroke, CKD, and cancers. In the three complication risk studies, glucose, BP, and blood lipids play significant roles. These risk factors have different degrees of impact on arteries, major blood vessels, the heart (heart attacks), the brain (stroke), micro-blood vessels damage of the kidney, nerve damage, and the overall influence on cancer prevalence. For example, BP causes artery ruptures (~20% to 30% of CVD/stroke cases) and blood lipids lead to artery blockages (~70% to 80% of CVD/stroke cases). The MPM research methodology can offer a quantitative picture regarding the degrees of damage or risk contributions for life-threatening complications. In addition, energy theory helps with the estimation of damages and expected lifespans.

As we know, lifestyle details cause rudimentary chronic diseases which further influence more complicated diseases, such as heart problems (CVD & CHD), chronic kidney disease (CKD), stroke, diabetic retinopathy (DR), neuropathy, hypothyroidism, and others. Some genetic conditions and lifetime unhealthy habits, such as smoking, alcohol consumption, and illicit drug use would account for approximately 15% to 25% of the root cause of rudimentary chronic diseases & their complications, including cancers and dementia. In addition to the genetic conditions, lifetime unhealthy habits and certain harmful external environmental factors, such as radiation, air and water pollution, food poison and pollution, toxic chemicals, and hormonal therapy, along with chronic inflammation can also contribute to the causes of a variety of cancers. All of the above-mentioned diseases fall into the category of "symptoms" which are the result of "root causes" from poor lifestyle and unhealthy habits.

Since December 2021, the author has written and published ~70 articles using the viscoelasticity and viscoplasticity theories (VGT) from physics and engineering disciplines on chosen medical subjects. These papers aim to explore some hidden biophysical behaviors and provide a quantitative understanding of inter-relationships between a selected symptom biomarker and a few intermediate steps that include a variety of selected multiple influential factors, "causes", or "risk factors". The hidden biophysical behaviors and possible inter-relationships between diseases, complications, or longevity and selected different sets of multiple risk factors are "time-dependent" which means that all of these variables are changing from time to time. This is why he utilizes VGT from physics and engineering to conduct his medical research work.

His research of various biomarkers starts from FPG. FPG not only sends some key messages regarding our health, such as pancreatic beta cells, but it also serves as the baseline of PPG. After contributing to PPG as its baseline, the influences from both carbs/sugar intake amount (a "plus" effect) and post-meal walking steps of exercise (a "minus" effect) then enter into the equation to form the ultimate PPG level. When combining FPG and PPG, the HbA1C level can then be determined. If hyperglycemic (i.e. high glucose level) conditions last for an extended period, diabetes is developed.

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Diabetes eventually damages many internal organs of the human body which may result in many complications, such as CVD, stroke, CKD, diabetic retinopathy (DR), neuropathy, foot ulcer, bladder infection, hypothyroidism, diabetic constipation, and skin fungal infection.

The research work behind the 70+ VGT papers since December 2021 is similar to his school days of doing homework 70 times on the same subject. Every exercise increases his understanding of the VGT application to biomedical problems. After accumulating these learned facts step-by-step, he then finally developed a detailed understanding of the overview of the VGT application in medicine.

This paper aims to explore some hidden biophysical behaviors which provide a quantitative sense of the inter-relationships between one symptom versus two selected major influential factors or risk factors. Of course, in the medical field, a symptom can turn into a cause of another symptom. For example, in this article, carbohydrates and sugar intake amount increase PPG while post-meal walking steps decrease PPG. Hook's law is applied in his predicted PPG equation as follows (he named it the linear elastic glucose theory or LEGT):

Predicted PPG
= (FPG * GH.f) + (carbs * GH.p) - (k-steps * GH.w)

Using a rigid rod member of a truss frame structure as a medical analogy. The truss member rod can only sustain the axial force, not the bending force. The tensile force is similar to the carbs/sugar FFT on PPG value while the compressive force is similar to the post-meal exercise on PPG value. The PPG's baseline, the FPG value, is similar to the inherent strength of the truss member rod. These three components constitute the final PPG value under stresses as described by the following equation:

Predicted PPG
= Original strength + tensile deformation - compressive deformation
= FPG * GH.f + carbs/sugar amount * GH.p - post-meal walking steps* GH.w

Where GH.x modulus is similar to Young's modulus in the theory of elasticity, for this medical analogy case:

GH.f = 0.9;
GH.p = 2.0;
GH.w = 5.0

The daily estimated average glucose (eAG) is a linear combination of both FPG and PPG, and for the finger-pierced glucose case:

eAG
= FPG * 0.25 + PPG * 0.75

Using the eAG value over a 90-120 days period and a simple conversion factor (around 16-18), we can estimate a highly accurate HbA1C value at the end of a quarter. HbA1C value indicates the severity of diabetes conditions. In this article, he adopts 120 mg/dL for eAG and 6.0% for A1C as the dividing line between healthy and unhealthy diabetes conditions.

Body weight determines the conditions of normal (BMI<25), overweight (BMI between 25 and 30), and obesity (BMI>30). Many research reports have already reported the close relationship between obesity and many complications, including diabetes, CVD, and cancers. Body weight can be a symptom of diseases, such as obesity and having a fatty liver. As a matter of fact, different cancers have identified being overweight or having obesity as one of their key risk factors.

Almost all the symptoms and their risk factors are "time-dependent" which means that all of these variables are changing from time to time. This is due to body cells changing constantly. That is why he utilizes VGT from physics and engineering to conduct his medical research work.

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

Strain
= ε (symptom)
= individual symptom value at the present time

Stress
= σ (based on the change rate of strain, symptom rate, multiplying with a chosen viscosity factor)

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= η * (dε/dt)
= η * (d-strain/d-time)
= (viscosity factor η using individual cause at present time) * (cause at present time - cause at a previous time)

Many causes (or viscosity factors as an engineering term) use normalized values to remove their association with different units which would enlarge or shrink the magnitude of stress values. This makes the interpretation and comparison of the result much more difficult. A few medical examples are listed below showing the normalized values as the dividing line between healthy and unhealthy conditions.

Normalized BMI = BMI / 25;
Normalized body temperature = BT / 98;
Normalized glucose = Glucose / 120;
Normalized A1C = A1C / 6.0

He defines the effective health age as follows in Papers No. 157, 313, 323, 466, 501, and 594:

Health Age
= Real Biological Age * (1+((MI-0.735)/0.735)/Amplification factor)

He calculates the "age difference" using the following formula:

Age difference
= health age - real biological

If this age difference is a positive value, then it means you are older than your real age due to poorer health, and vice versa.

In VGT energy analysis, he then calculates the respective hysteresis loop areas (via trapezoid formula) associated with various components of stress to judge the energy levels associated with each viscosity factor or cause.

Furthermore, he can use the stress and strain data to develop a pseudo-perturbation model for his predicted symptom:

Predicted Symptom
= strain value + stress value
= Symptom + (d-Symptom/d-time) * (normalized Cause)

The normalized viscosity factor would provide a numerical value around 1.0 which is much smaller than the "real" measure symptom (strain) value. This fact makes the relatively smaller stress value a perfect candidate for the application of the perturbation theory for medical problems.

At this point, it is necessary to briefly describe his health history. The author was diagnosed with T2D in 1997 with a random glucose check at a 300 mg/dL level; however, his T2D condition most likely began earlier (he guesses in 1995). He suffered his first two chest pain episodes in 1993-1994 and three more heart episodes until 2007. His primary physician informed him that he had diabetic kidney issues in 2010. He then consulted with two more clinical doctors who advised him to immediately start insulin injections and kidney dialysis. This was his wake-up call. He then decided to save his own life by conducting a self-study and research on food nutrition and chronic diseases that same year. His health profile in 2010 was: body weight at 220 lbs. (BMI 32, indicating obesity), average glucose at 280 mg/dL (>140 mg/dL, signifying diabetes), fasting plasma glucose (FPG) in the early morning at 180 mg/dL (>126 mg/dL, depicting hyperinsulinemia), lab-tested HbA1C at 10% which means severe diabetes, triglycerides at 1160 mg/dL reflecting hyperlipidemia (target: <150 mg/dL), and his ACR at 116 which indicates kidney damage (target: <30). In summary, by 2010, he has also suffered a total of five heart episodes, CKD, hypothyroidism, diabetic retinopathy, foot ulcer, neuropathy, diabetic constipation, diabetic skin fungal infection, etc.

Over the past ~13 years, he has made significant lifestyle changes. For example, he consumes less than 15 grams of carbohydrates and sugar per meal (his target is below 15 to 20 grams of carbs/sugar intake amount), avoids processed food, reduces his food quantity by 50%, walks 6-7 miles or 10-11 kilometers daily (his target is 9,000 to 12,000 steps each day), sleeps 7-8 hours each night, and reduces stress as much as possible. In addition, he has never drunk alcohol, smoked cigarettes, or used any illicit drugs in his life.

As of April 25, 2022, his health profile for the first 4 months of 2022 was: body weight at 169 lbs. (BMI 24.95 which is normal weight), daily average glucose at 106 mg/dL, FPG in the early morning at 94 mg/dL, lab-tested

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A1C at 5.8% which is the beginning level of pre-diabetes, triglycerides at 108, and ACR at 16. Another significant accomplishment is that he has discontinued taking 3 different kinds of diabetes medications since 12/8/2015.

2. METHODS

To offer a simple explanation to readers who do not have a physics or engineering background, the author includes a brief excerpt from Wikipedia regarding the description of basic concepts for elasticity and plasticity theories, viscoelasticity, and viscoplasticity theories from the disciplines of engineering and physics and his developed metabolism Index (MI) model in this method section.

2.1 Relationships between biomedical causes and biomedical symptoms

As a mathematician/engineer over 40 years and now conducting his medical research work for the past 13 years, the author has discovered that people frequently seek answers, illustrations, or explanations for the relationships between the input variable (force applied on a structure or cause of a disease) and output variable (deformation of a structure or symptom of a disease). However, the multiple 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, which is a symptom of certain causes that can become a cause of another different symptom. This phenomenon is indeed a complex scenario with "chain effects". In fact, both engineering and biomedical complications are fundamentally mathematical problems that correlate or conform with many inherent physical laws or principles. In his medical research work, he has encountered more than 100 different sets of biomarkers with almost equal or more amounts of causes (or input variables) and symptoms (or output variables).

Since December of 2021, the author applied theories of viscoelasticity and viscoplasticity (VGT) from physics and engineering disciplines to investigate more than 60 sets of input/output biomarkers, including nearly 10 sets of cancer cases. The purpose is to identify certain hidden relationships between certain output biomarkers, such as cancer risk, and its corresponding multiple inputs, such as glucose, blood pressure, blood lipids, obesity or overweight, and metabolism index of 6 lifestyle details and 4 chronic diseases. In this study, the hidden biophysical behaviors and possible inter-relationships among the output symptom and multiple input causes are "time-dependent" and change from time to time. These important time-dependency characteristics provide insight into the cancer risk's moving pattern. It also controls the cancer risk curve shape, the associated energy created, stored, or burned inside during the process of stress up-loading (moving upward or increasing) and stress down-loading (moving downward or decreasing) of the input biomarkers with the output biomarker of cancer risk %. This VGT application emphasizes the time-dependency characteristics of involved 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, known as a "hysteresis loop" in physics, in which area size can also be used to estimate the relative energy created, stored, or burned during the process of uploading (e.g., increasing glucose) and unloading (e.g., decreasing body weight) over the timespan of the cancer risk %. He calls this relative energy the "VGT energy".

It should be emphasized here that both cancer risk % and its associated VGT energy are estimated relative values, not "absolute" values.

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

VGT strain
= ε (symptom)
= individual symptom at the present time

VGT stress
= σ (based on the change rate of strain, symptom, multiplying with one or more viscosity factors or influential factors)
= $\eta * (d\varepsilon/dt)$
= η * (d-strain/d-time)

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= (viscosity factor η using normalized factor at present time) * (symptom at present time - symptom at a previous time)

Where the strain is the cancer risk percentage and the stress is his cancer risk change rate multiplied by several chosen input biomarkers as the individual viscosity factor. In his VGT studies, sometimes, he carefully selects certain normalization factors for each input biomarker, respectively. The normalization factors are the dividing lines between a healthy state and an unhealthy state. For example, 170 lbs. for body weight, 6.0 for HbA1C, 120 mg/dL for glucose, 180 mg/dL for hyperglycemia, 73.5% for overall MI score, and 10,000 steps for daily walking exercise, etc.

2.2 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.

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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.

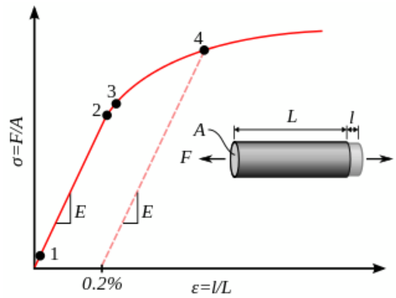
In engineering, the elasticity of a material is quantified by the elastic modulus such as the Young's modulus, bulk modulus or shear modulus which measure the amount of stress needed to achieve a unit of strain; a higher modulus indicates that the material is harder to deform. The material's elastic 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):

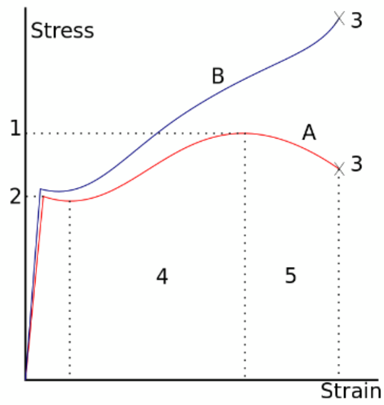
Deformation of a solid material undergoing non-reversible changes of shape in response to applied forces.

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

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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).

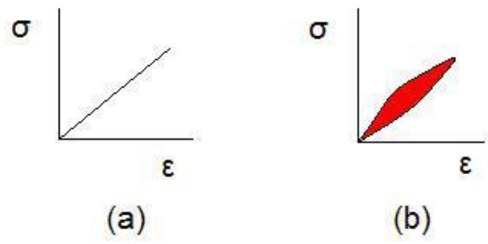
Depending on the change of strain rate versus stress inside a material, the viscosity can be categorized as having a linear, non-linear, or plastic response. In addition, when the stress is independent of this strain rate, the material exhibits plastic deformation. Many viscoelastic materials exhibit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

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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
= $\oint \sigma d\varepsilon$

2.3 Metabolism index (MI) model

This model was developed in Y2014 by the author using the topology concept, nonlinear algebra, geometric algebra, and engineering finite element method. In summary, the human body metabolism is a complex mathematical problem with a matrix format of m causes by n symptoms, plus sometimes, one symptom or many symptoms would be turned into causes of another symptom.

This MI model contains 10 specific categories, including 4 output categories of medical conditions (body weight, glucose, blood pressure, and lipids), and 6 input categories of lifestyle details (food quantity and quality, drinking water intake, physical exercise, sleep, stress, and daily life routines). These 10 categories are comprised of approximately 500 detailed elements. He has also defined two new resulting parameters: the metabolism index or MI, as the combined score of the above 10 metabolism categories and 500 elements using his developed algorithm, along with the general health status unit (GHSU), as the 90-day moving average value of MI.

A physical analogy of this complex mathematical metabolism model is similar to "using multiple nails that are encircled by many rubber bands". For example, at first, we hammer 10 nails into a piece of flat wood with an initial shape of a circle, then take 3,628,800 (=10!) rubber bands to encircle the nails, including all 10 nails. These ~3.6 million rubber bands (i.e. big number of relationships) indicate the possible relationships existing among these 10 nails (i.e. 10 original metabolism data). Some rubber bands encircle 2 nails or 3 nails and so on until the last rubber band encircles all of these 10 nails together (no rubber band to encircle a single nail is allowed). Now, if we move any one of the nails outward (i.e., moving away from the center of the nail circle), then this moving action would create some internal tension inside the encircled rubber band. Moving one nail "outward" means one of these ten metabolism categories is becoming "unhealthy" which would cause some stress to our body. Of course, we can also move some or all of the 10 nails outward at the same time, but with different moving scales. If we can measure the summation of the internal tension created in the affected rubber bands, then this summarized tension force is equivalent to the metabolism value of human health. The higher tension means a higher metabolism value which creates an unhealthy situation. The author uses the above-described scenario of moving nails and their encircled rubber bands to explain his developed mathematical metabolism model of human health.

During 2010 and 2011, the author collected sparse biomarker data, but from the beginning of 2012, he has been gathering his body weight and finger-piercing glucose values each day. More complete data collection started in Y2015. In addition, he accumulates medical conditions data including BP, heart rate (HR), and blood lipids along with lifestyle details (LD). Since 2020, he has added the daily body temperature (BT) and blood oxygen level (SPO2) due to his concerns about being exposed to COVID-19. Based on the collected big data of biomarkers, he further organized

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them into two main groups. The first is the medical conditions group (MC) with 4 categories: weight, glucose, BP, and blood lipids. The second is the lifestyle details group (LD) with 6 categories: food & diet, exercise, water intake, sleep, stress, and daily routines. At first, he calculated a unique combined daily score for each of the 10 categories within the MC and LD groups. The combined scores of the 2 groups, 10 categories, and 500+ detailed elements constitute an overall "metabolism index (MI) model". It includes the root causes of 6 major lifestyle inputs and symptoms from 4 lifestyle-induced rudimentary chronic diseases, i.e. obesity, diabetes, hypertension, and hyperlipidemia. Therefore, the MI model, especially its 4 chronic disease conditions, can be used as the foundation and building block for his additional research work that can expand into various complications associated with different organs, such as cancer.

Of course, the same methodology can be extended to the study of many other medical complications, such as various heart problems (CVD & CHD), stroke, neuropathy, hypothyroidism, diabetic constipation, diabetic skin fungal infection, various cancers, and dementia.

In general, some genetic conditions and lifetime unhealthy habits, which include tobacco smoking, alcohol drinking, and illicit drug use, account for approximately 15% to 25% of the root cause of chronic diseases and their complications, as well as cancers and dementia.

His calculated risk probability % for CKD, CVD, DR, stroke, and various cancers have some differences in their root-cause variables, their associated weighting factors for each key cause, and certain biomedical interpretations and assumptions. Specifically, the CVD/Stroke risk includes two major scenarios that combine emphasized weighting factors, blood vessel blockage due to blood glucose and blood lipids, and blood vessel rupture caused by blood glucose and blood pressure. Some recent research work has identified the relationship between pancreatic cancer with hyperglycemia and insulin resistance phenomena of T2D and chronic inflammation. Some aggressive prostate cancers are linked to 5 types of bacteria. There is also evidence of a relationship between BP and DR (Reference: BP control and DR, by R. Klein and BEK Klein from British Journal of Ophthalmology). The CKD risks include hyperglycemic damage to micro-blood vessels and nerves which causes protein leakage found in urine and waste deposit within the kidneys; therefore, it requires dialysis to remove waste products and excess fluids from the body. However, the cancer risk also consists of additional influences from environmental conditions, such as improper medications, viral infections, food pollution or poison, toxic chemical, radiation, air and water pollution, hormonal treatment, etc.

All of the above-mentioned diseases fall into the category of "symptoms" which are the outcomes of "root causes" of genetic conditions, unhealthy lifestyles, and poor living environments.

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 4 data tables associated with 4 VGT analyses respectively. They depict the collected original data, normalized viscosity factors, strain rate, stress, and hysteresis loop areas.

5/7/22	eAG	FPG	PPG	Norm. FPG	Norm. PPG	PPG Rate	Strain (eAG)	Stress (FPG)	Stress (PPG)	Area (FPG)	Area (PPG)	4-yrs steps	4-yrs carbs
Y2012	185.00	138.00	200	1.15	1.67	0	185	0.0	0.0	0	0		
Y2013	169.00	135.00	180	1.13	1.50	-16	169	-18.0	-24.0	144	192		
Y2014	134.65	121.00	137	1.01	1.14	-34	135	-34.6	-39.3	904	1087	90%	91%
Y2015	128.66	120.58	130	1.00	1.08	-6	129	-6.0	-6.5	122	137	1170	1416
Y2016	119.42	117.03	120	0.98	1.00	-9	119	-9.0	-9.3	69	73	7-yrs carbs	7-yrs steps
Y2017	117.38	119.76	117	1.00	0.97	-2	117	-2.0	-2.0	11	11		
Y2018	116.39	113.73	117	0.95	0.97	-1	116	-0.9	-1.0	1	1		
Y2019	114.38	114.55	114	0.95	0.95	-2	114	-1.9	-1.9	3	3		
Y2020	106.24	100.97	108	0.84	0.90	-8	106	-6.8	-7.3	36	38		
Y2021	104.63	93.76	108	0.78	0.90	-2	105	-1.3	-1.5	7	7	10%	9%
Y2022	105.71	93.99	109	0.78	0.91	1	106	0.8	1.0	0	0	127	133
Average	127	115	131	0.96	1.09	-7	127	-7.3	-8.3	1297	1549		
				47%	53%					46%	54%		

5/7/22	CVD %	BW	T2D (eAG)	Norm. BW	Norm. eAG	PPG Rate	Strain (PPG)	Stress (BW)	Stress (T2D)	Area (BW)	Area (T2D)	4-yrs steps	4-yrs carbs
Y2012	85	189.03	185.00	1.11	1.54	0	85	0.0	0.0	0	0		
Y2013	86	182.57	169.00	1.07	1.41	1	86	1.1	1.4	1	1		
Y2014	74	177.23	134.65	1.04	1.12	-12	74	-12.5	-13.5	69	72	79%	80%
Y2015	62	175.40	128.66	1.03	1.07	-12	62	-12.4	-12.9	149	158	219	231
Y2016	57	172.94	119.42	1.02	1.00	-5	57	-5.1	-5.0	44	45	7-yrs carbs	7-yrs steps
Y2017	55	174.29	117.38	1.03	0.98	-2	55	-2.1	-2.0	7	7		
Y2018	55	171.09	116.39	1.01	0.97	0	55	0.0	0.0	0	0		
Y2019	56	172.57	114.38	1.02	0.95	1	56	1.0	1.0	1	0		
Y2020	52	170.02	106.24	1.00	0.89	-4	52	-4.0	-3.5	6	5		
Y2021	52	168.58	104.63	0.99	0.87	0	52	0.0	0.0	0	0	21%	20%
Y2022	51	169.47	105.71	1.00	0.88	-1	51	-1.0	-0.9	0	0	58	58
Average	62	175	127	1.03	1.06	-3	62	-3.2	-3.2	276	289		
				49%	51%					49%	51%		

5/7/22	Health Age	Cancer %	CVD %	Norm. Cancer	Norm. eAG	PPG Rate	Strain (PPG)	Stress (Cancer)	Stress (CVD)	Area (Cancer)	Area (CVD)	4-yrs Cancers	4-yrs CVD
Y2012	78	57	85	57	85	0	78	0.0	0.0	0	0		
Y2013	76	53	86	53	86	-2	76	-106.0	-172.0	106	172		
Y2014	70	50	74	50	74	-6	70	-300.0	-444.0	1218	1848	92%	92%
Y2015	64	46	62	46	62	-6	64	-276.0	-372.0	1728	2448	3052	4468
Y2016	63	43	57	43	57	-1	63	-43.0	-57.0	160	215	7-yrs Cancers	7-yrs CVD
Y2017	63	41	55	41	55	0	63	0.0	0.0	0	0		
Y2018	64	42	55	42	55	1	64	42.0	55.0	21	28		
Y2019	65	42	56	42	56	1	65	42.0	56.0	42	56		
Y2020	63	41	52	41	52	-2	63	-82.0	-104.0	40	48		
Y2021	64	40	52	40	52	1	64	40.0	52.0	-21	-26	8%	8%
Y2022	65	40	51	40	51	1	65	40.0	51.0	40	52	282	371
Average	67	45	62	45	62	-1	67	-58.5	-85.0	3334	4839		
				42%	58%					41%	59%		

5/7/22	Health Age	Cancer %	CVD %	Norm. Cancer	Norm. CVD	PPG Rate	Strain (PPG)	Stress (Cancer)	Stress (CVD)	Area (Cancer)	Area (CVD)	4-yrs Cancers	4-yrs CVD
Y2012	78	57	85	57	85	0	78	0.0	0.0	0	0		
Y2013	76	53	86	53	86	-2	76	-106.0	-172.0	106	172		
Y2014	70	50	74	50	74	-6	70	-300.0	-444.0	1218	1848	92%	92%
Y2015	64	46	62	46	62	-6	64	-276.0	-372.0	1728	2448	3052	4468
Y2016	63	43	57	43	57	-1	63	-43.0	-57.0	160	215	7-yrs Cancers	7-yrs CVD
Y2017	63	41	55	41	55	0	63	0.0	0.0	0	0		
Y2018	64	42	55	42	55	1	64	42.0	55.0	21	28		
Y2019	65	42	56	42	56	1	65	42.0	56.0	42	56		
Y2020	63	41	52	41	52	-2	63	-82.0	-104.0	40	48		
Y2021	64	40	52	40	52	1	64	40.0	52.0	-21	-26	8%	8%
Y2022	65	40	51	40	51	1	65	40.0	51.0	40	52	282	371
Average	67	45	62	45	62	-1	67	-58.5	-85.0	3334	4839		
				42%	58%					41%	59%		

Figure 1: 4 data tables and calculation results of 4 individual VGT analysis.

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Figure 2 illustrates 4 stress-strain diagrams from 4 separate VGT analyses: PPG vs. carbs & steps, eAG vs. FPG & PPG, CVD risk vs. obesity & T2D, and health age (longevity) vs. cancers & CVD.

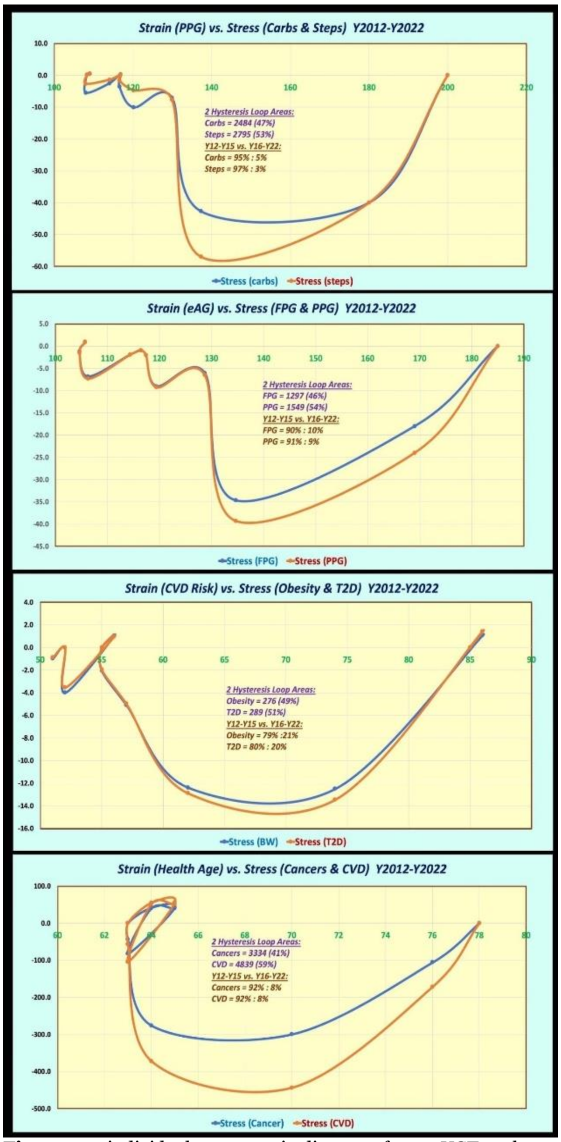

Figure 2: 4 individual stress-strain diagrams from 4 VGT analyses.

Figure 3 reflects a data table of original collected biomarker and lifestyle data with their original units. A combined VGT analysis result has shown the final results of this "chain-effect" of the 4 separated VGT analyses.

Figure 4 reveals the stress-strain diagram of the combined "chain-effect" VGT analysis of longevity vs. cancers, CVD, T2D, and obesity.

Chain-effect of 4 VGT cases													
5/7/22								25%	75%	1.6	5.0	LEGT	Finger
	Real Age	Health Age	Health-Real	Cancer %	CVD %	BW	eAG	FPG	PPG	Carbs gram	K-Steps	Predicted PPG	Predicted eAG
Y2012	65	78	13	57	85	189.03	185.00	138.00	200	40.00	0.500	200	185
Y2013	66	76	10	53	86	182.57	169.00	135.00	180	30.00	1.000	178	169
Y2014	67	70	3	50	74	177.23	134.65	121.00	137	15.00	1.500	138	133
Y2015	68	64	-4	46	62	175.40	128.66	120.58	130	14.28	1.904	134	128
Y2016	69	63	-6	43	57	172.94	119.42	117.03	120	15.55	4.106	121	119
Y2017	70	63	-7	41	55	174.29	117.38	119.76	117	14.52	4.440	121	117
Y2018	71	64	-7	42	55	171.09	116.39	113.73	117	15.82	4.538	116	116
Y2019	72	65	-7	42	56	172.57	114.38	114.55	114	13.24	4.038	116	114
Y2020	73	63	-10	41	52	170.02	106.24	100.97	108	13.68	4.468	101	106
Y2021	74	64	-10	40	52	168.58	104.63	93.76	108	12.77	4.057	94	105
Y2022	75	65	-10	40	51	169.47	105.71	93.99	109	10.92	4.021	91	105
Average	70	67	-3	45	62	175	127	115	131	18	3.14	128	127
Correl / Accur			100%	99%	99%								
Correl / Accur					100%	94%	96%						
Correl / Accur							100%	88%	100%			PPG Accuracy	eAG Accuracy
Correl / Accur									100%	96%	-89%	97.8%	99.7%

Original						Normalized				/ 120	/ 170
5/7/22	Health Age	Cancer %	CVD %	T2D (eAG)	Obesity (BW)	5/7/22	Health Age	Cancer %	CVD %	T2D (eAG)	Obesity (BW)
Y2012	78	57	85	185	189	Y2012	78	0.57	0.85	0.71	1.11
Y2013	76	53	86	169	183	Y2013	76	0.53	0.86	0.72	1.07
Y2014	70	50	74	135	177	Y2014	70	0.50	0.74	0.62	1.04
Y2015	64	46	62	129	175	Y2015	64	0.46	0.62	0.52	1.03
Y2016	63	43	57	119	173	Y2016	63	0.43	0.57	0.48	1.02
Y2017	63	41	55	117	174	Y2017	63	0.41	0.55	0.46	1.03
Y2018	64	42	55	116	171	Y2018	64	0.42	0.55	0.46	1.01
Y2019	65	42	56	114	173	Y2019	65	0.42	0.56	0.47	1.02
Y2020	63	41	52	106	170	Y2020	63	0.41	0.52	0.43	1.00
Y2021	64	40	52	105	169	Y2021	64	0.40	0.52	0.43	0.99
Y2022	65	40	51	106	169	Y2022	65	0.40	0.51	0.43	1.00
Average	67	45	62	127	175	Average	67	0.45	0.62	0.52	1.03
Correlation	100%	94%	95%	94%	91%	Correlation	100%	94%	95%	95%	91%

5/7/22	PPG Rate	Strain (Age)	Stress (Cancer)	Stress (CVD)	Stress (T2D)	Stress (Obesity)	5/7/22	Area (Cancer)	Area (CVD)	Area (T2D)	Area (Obesity)
Y2012	0	78	0.0	0.0	0.0	0.0	Y2012	0	0	0	0
Y2013	-2	76	-1.1	-1.7	-1.4	-2.1	Y2013	1	2	1	2
Y2014	-6	70	-3.0	-4.4	-3.7	-6.3	Y2014	12	18	15	25
Y2015	-6	64	-2.8	-3.7	-3.1	-6.2	Y2015	17	24	20	37
Y2016	-1	63	-0.4	-0.6	-0.5	-1.0	Y2016	2	2	2	4
Y2017	0	63	0.0	0.0	0.0	0.0	Y2017	0	0	0	0
Y2018	1	64	0.4	0.6	0.5	1.0	Y2018	0	0	0	1
Y2019	1	65	0.4	0.6	0.5	1.0	Y2019	0	1	0	1
Y2020	-2	63	-0.8	-1.0	-0.9	-2.0	Y2020	0	0	0	1
Y2021	1	64	0.4	0.5	0.4	1.0	Y2021	0	0	0	-1
Y2022	1	65	0.4	0.5	0.4	1.0	Y2022	0	1	0	1
Average	-1	67	-0.6	-0.9	-0.7	-1.2	Sum Area	33	48	40	71
Contribution	Total Stress	-3.4	17%	25%	21%	37%	193	17%	25%	21%	37%

Figure 3: Data table and calculation results of the combined chain-effect of VGT analysis.

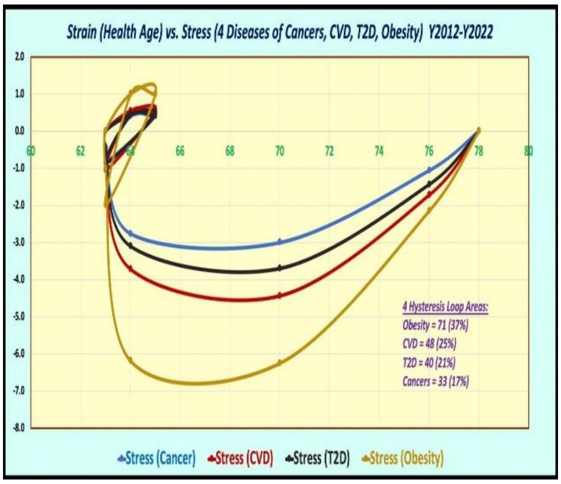

Figure 4: A combined stress-strain diagram from the chain-VGT analysis.

4. CONCLUSION

With the 4 individual VGT analyses results, he observes the following 3 clear conclusions in Figure 2:

(1) Looking into the x-axes of 4 individual stress-strain diagrams, all of their strain values (i.e. symptoms) are improving year after year.

(2) The hysteresis loop areas of the first 4 years (from Y2012 to Y2015) versus the recent 7 years (from Y2016 to Y2022) are 79%-97% versus 3% to 21%. This indicates that his earlier 4 years have contributed

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much more energy to his body health than his recent 7 years.

(3) In these 4 individual VGT analyses, each diagram has one symptom with two selected causes. The energy ratios between the first cause versus the second cause are 41% to 49% versus 51% to 59% (about a 50/50 split). This indicates that the two causes contribute almost equal amounts of energy to the symptom. This phenomenon resulted from the normalization process of all viscosity factors.

Figure 4 demonstrated the combined "chain-effect" of one symptom for longevity through health age versus 4 selected causes of disease: CVD (No. 1 cause of death), cancers (No. 2), diabetes (No. 8), and obesity, which is a common risk factor for many complications and deaths. Although the author can select a different set or add more causes for longevity research, the purpose of this study is to demonstrate the chain application using a VGT tool. Therefore, he chose carbs and exercise contribution to glucose, from diabetes and heart attacks, then combined CVD with cancers, diabetes, and obesity to study the patient's reduced expected lifespan.

The key observation in Figure 4 is that the calculated 4 loop areas are Cancers at 17%, T2D at 21%, CVD at 25%, and Obesity at 37%.

(1) The MI-based cancer risk contribution is relatively lower than the MI-based CVD risk contribution over the past 11 years. This finding is a result of the first fact that he has no signs of cancer thus far and the second fact that he has already suffered 5 heart episodes 5 in the past. The result of cancers versus CVD explained why his cancer energy area is the smallest one and the CVD energy area is larger than the cancer energy.

(2) His Diabetes (T2D) energy is the second smallest one due to stringent lifestyle management and persistent glucose improvement over the past 11 years. This can be proven via his 280 mg/dL in 2010 (A1C 10%) and 106 mg/dL in 2022 (A1C 5.8%).

(3) The obesity (bodyweight) condition changes can be seen from his BMI of 32 in 2010 to a BMI of 25 in 2010, and then to his BMI of 24.9 in 2022. Over the past 11 years, his BMI values have been mostly above 25. The normalization process puts his bodyweight stress values around 1.0 or higher which is higher than other normalized viscosity factors. This explains why obesity contributes the highest energy to the longevity symptom. This further indicates the importance of weight control in terms of overall health maintenance.

In summary, the VGT energy tool can be applied to the individual analysis and the combined chain analysis of carbs/steps to PPG, eAG (T2D), CVD, and longevity. If other medical research scientists utilize this math-physical medicine (MPM) methodology, such as LEGT or VGT tools, they can obtain a statistical analysis based on multiple patients' data first, then assemble them with the author's MPM analysis results. This combined approach can then summarize the MPM results into a wider-view statistical conclusion with a more rigorous and solid math-physical information as the foundation support.

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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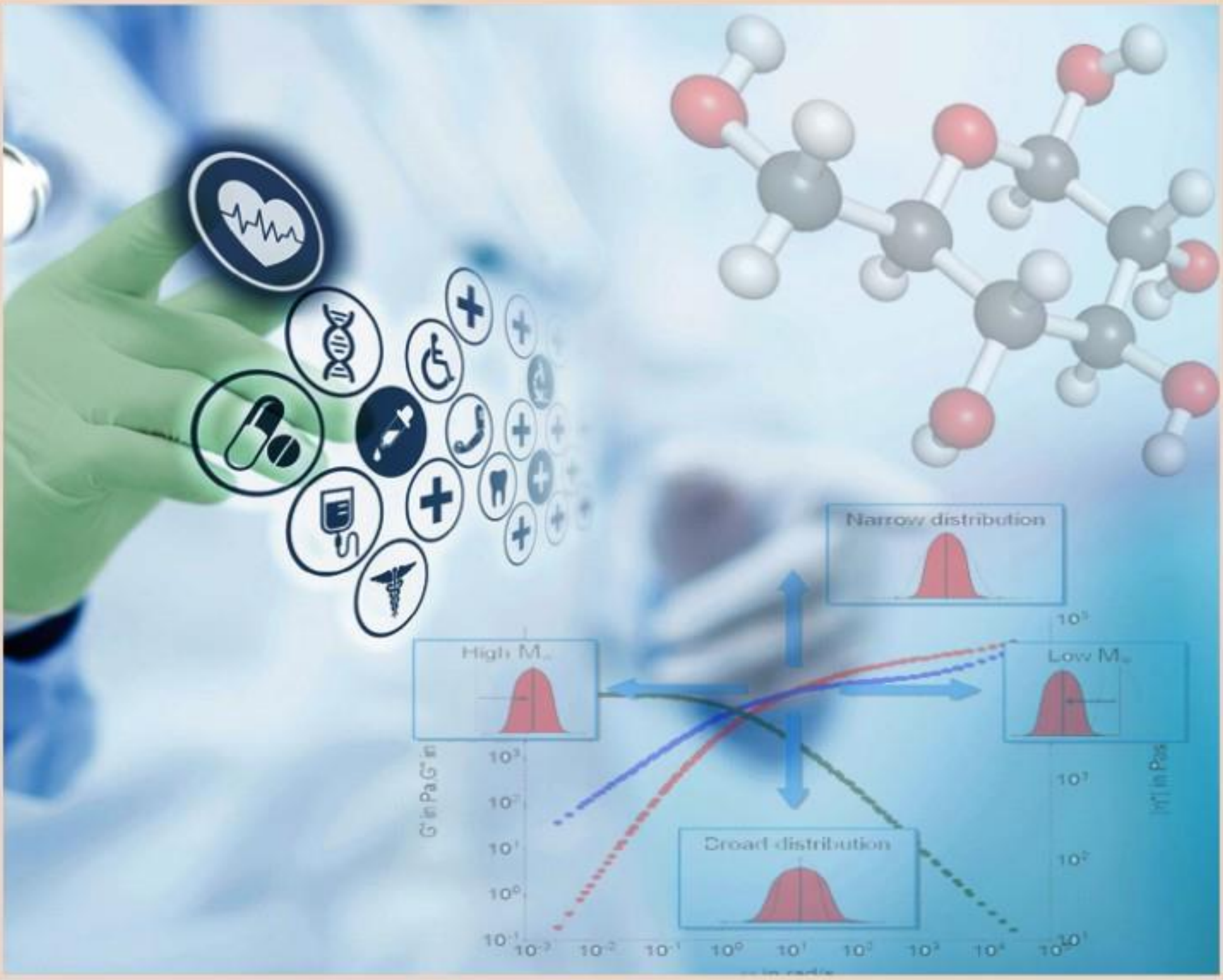

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