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Research Article

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Viscoelastic and viscoplastic glucose theory (VGT #121): Prevention of breast cancer via weight control, daily exercise, and food quality using a dataset over 11.5 years with 12 annual data of a hypothetic female patient based on GH-method: math-physical medicine (No. 711)

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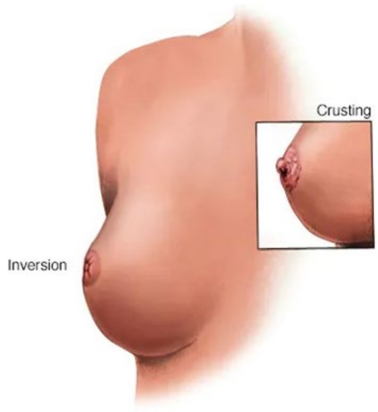
Introduction

This paper starts with a brief excerpt from Mayo Clinic's website "Breast cancer care at Mayo Clinic

"Breast cancer is cancer that forms in the cells of the breasts.

After skin cancer, breast cancer is the most common cancer diagnosed in women in the United States. Breast cancer can occur in both men and women, but it's far more common in women.

Breast cancer survival rates have increased, and the number of deaths associated with this disease is steadily declining, largely due to factors such as earlier detection, a new personalized approach to treatment, and a better understanding of the disease.



Symptoms

Signs and symptoms of breast cancer may include:

- *A breast lump or thickening that feels different from the surrounding tissue*
- *Change in the size, shape, or appearance of a breast*
- *Changes to the skin over the breast, such as dimpling*
- *A newly inverted nipple*
- *Peeling, scaling, crusting, or flaking of the pigmented area of skin surrounding the nipple (areola) or breast skin*
- *Redness or pitting of the skin over your breast, like the skin of an orange.*

Causes

Doctors know that breast cancer occurs when some breast cells begin to grow abnormally. These cells divide more rapidly than healthy cells do and continue to accumulate, forming a lump or mass. Cells may spread (metastasize) through your breast to your lymph nodes or to other parts of your body.

Breast cancer most often begins with cells in the milk-producing ducts (invasive ductal carcinoma). Breast cancer may also begin in the glandular tissue called lobules (invasive lobular carcinoma) or in other cells or tissue within the breast.

Researchers have identified hormonal, lifestyle and environmental factors that may increase your risk of breast cancer. *But it's not clear why some people who have no risk factors develop cancer, yet other people with risk factors never do.* ***It's***

likely that breast cancer is caused by a complex interaction of your genetic makeup and your environment.

Inherited breast cancer

Doctors estimate that about 5 to 10 percent of breast cancers are linked to gene mutations passed through generations of a family.

Risk factors:

A breast cancer risk factor is anything that makes it more likely you'll get breast cancer. But having one or even several breast cancer risk factors doesn't necessarily mean you'll develop breast cancer. *Many women who develop breast cancer have no known risk factors other than simply being women.*

Factors that are associated with an increased risk of breast cancer include:

- ***Being female.*** *Women are much more likely than men are to develop breast cancer.*
- ***Increasing age.*** *Your risk of breast cancer increases as you age.*
- ***A personal history of breast conditions.*** *If you've had a breast biopsy that found lobular carcinoma in situ (LCIS) or atypical hyperplasia of the breast, you have an increased risk of breast cancer.*
- ***A personal history of breast cancer.*** *If you've had breast cancer in one breast, you have an increased risk of developing cancer in the other breast.*
- ***A family history of breast cancer.*** *If your mother, sister or daughter was diagnosed with breast cancer, particularly at a young age, your risk of breast cancer is increased.* ***Still, the majority of people diagnosed with breast cancer have no family history of the disease.***
- ***Inherited genes that increase cancer risk.*** *Certain gene mutations that increase the risk of breast cancer can be passed from parents to children. The most well-known gene mutations are referred to as BRCA1 and BRCA2. These genes can greatly increase your risk of breast cancer and other cancers, but they don't make cancer inevitable.*
- ***Radiation exposure.*** *If you received radiation treatments to your chest as a child or young adult, your risk of breast cancer is increased.*
- ***Obesity. Being obese increases your risk of breast cancer.***
- ***Beginning your period at a younger age*** *(before age 12).*
- ***Beginning menopause at an older age.***
- ***Having your first child at an older age*** *(after age 30).*
- ***Having never been pregnant****. Women who have never been pregnant have a greater risk of breast cancer than women who have had one or more pregnancies.*
- ***Postmenopausal hormone therapy.*** *Women who take hormone therapy medications that combine estrogen and progesterone to treat the signs and symptoms of menopause have an increased risk of breast cancer. The risk of breast cancer decreases when women stop taking these medications.*
- ***Drinking alcohol.*** *Drinking alcohol increases the risk of breast cancer.*

Prevention:

Breast cancer risk reduction for women with average risk:

Making changes in your daily life may help reduce your risk of breast cancer. *Try to:*

- *Ask your doctor about breast cancer screening.*
- *Become familiar with your breasts through a breast self-exam for breast awareness.*
- *Drink alcohol in moderation, if at all.*
- *Limit postmenopausal hormone therapy.*
- ***Exercise most days of the week. Aim for at least 30 minutes of exercise on most days of the week. If you haven't been active lately, ask your doctor whether it's OK and start slowly.***
- ***Maintain a healthy weight. If your weight is healthy, work to maintain that weight. If you need to lose weight, ask your doctor about healthy strategies to accomplish this. Reduce the number of calories you eat each day and slowly increase the amount of exercise.***
- ***Choose a healthy diet. Women who eat a Mediterranean diet supplemented with extra-virgin olive oil and mixed nuts may have a reduced risk of breast cancer. The Mediterranean diet focuses mostly on plant-based foods, such as fruits and vegetables, whole grains, legumes, and nuts. People who follow the Mediterranean diet choose healthy fats, such as olive oil, over butter and fish instead of red meat."***

The author's interests in his medical research work have been in the scope of lifestyle management, overall metabolism improvement, diabetes control, and chronic metabolic-disorder induced deadly diseases, such as heart attack, stroke, kidney failure, dementia, and various cancers. The genetic factors and gene mutations mentioned in the Mayo Clinic article are beyond the patient's control. In addition, the patient's lifetime bad habits, such as tobacco smoking and alcohol drinking, and personal exposures to hormonal treatments and various environmental hazards, such as radiation, pollution, etc. are complex issues. As stated in the article, "It's likely that breast cancer is caused by a complex interaction of genetic makeup and environment.***" The author decides not to include these genetic and environmental factors in this study. He focuses on 3 controllable lifestyle items only, i.e. weight control, daily exercise, and food quality (not food quantity which is included in the weight control), for preventing breast cancer or at least lowering its risk probability.***

The author is a mathematician and engineer who has conducted medical research work over the past 13 years since 2010 in the multiple fields of endocrinology, metabolic disorder-induced chronic diseases (especially diabetes), and their resulting various medical complications. Thus far, he has written and published 700+ research papers in 100+ journals using different math-physical medicine methodologies (MPM).

Beginning with paper No. 578 dated 1/8/2022, he has written 115 various biomedical papers and 5 papers related to economic indexes and COVID pandemic situations using viscoelasticity and viscoplasticity theories (VGT). These various papers aim to explore some hidden physical behaviors and provide a quantitative description, subtle findings, or deeper interpretations of the inter-relationships of a selected output (symptom) versus singular input or multiple inputs (root causes, risk factors, or influential factors).

In the field of medical research, the hidden biophysical behaviors and possible inter-relationships exist among lifestyle details, medical conditions, chronic diseases, and certain medical complications, such as heart attacks, stroke, cancers, dementia, and even longevity concerns. He has noticed that most 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 organic and dynamically changing.*** *This is what* **Professor Norman Jones***, the author's adviser at MIT,* ***suggested to him in December of 2021*** *and why he utilizes the VGT tools from physics and engineering to conduct his medical research work since then.*

In this article, since the metabolism index values of m1 (body weight or obesity), m9a (food quality), and m5 (walking exercise) have already been normalized in the process of data entry, therefore these three normalization factors for weight, exercise, and food quality are 1.0.

It should also be mentioned that the author has developed a mathematical model for estimating the risk probability of developing various cancers based on his developed metabolism index (MI) model in 2014. His MI model contains 10 categories, 4 medical conditions, i.e. obesity, diabetes, hypertension, and hyperlipidemia, and 6 lifestyle details, i.e. food & diet, drinking water, exercise, sleep, stress, and daily life routines. This MI model calculates a daily MI score based on all input health data. Furthermore, based on certain special influences, stimulators and situations, this MI model can then be further modified and turned it into an estimation tool for a variety of cancers or medical complications, such as heart attack, stroke, kidney failure, retinopathy, etc.

Method

TD, SD, and FD Analysis tools:

In this particular paper, the author decides to omit the FD study. However, in this section of Method, he still includes frequency-domain method description.

This section has brief descriptions of time-domain (TD) correlation analysis with other observational results, space-domain (SD) VGT analysis with hysteresis loop area's energy results, and frequency-domain (FD) analysis with frequency curve area's energy results.

First of all, using a TD analysis tool, we can examine the curves' moving trend and pattern visually, and also the curves' correlation numerically. We can also study those extremely high or low data values in the dataset. The visual observation or calculation derived interpretations are a part of statistical analysis which can indeed provide some useful hints or even derive some accurate conclusions. ***However, we must be aware of the limitation of the data we select and be cautious of the appropriate statistics tool we choose.***

The author would like to describe the essence of his developed ***"hybrid model" that combines both space-domain (SD) visco-elastic/plastic VGT analysis method and frequency-domain (FD) fast Fourier transform (FFT) analysis method together with a comparison against the traditional time-domain statistical correlation analysis.***

It is described in 10 steps instead of using mathematical equations to explain it. ***In this article, he has applied both the SD-VGT operations (steps 1-7) and the FD-FFT operations (steps 8-10).*** As a result, it is aimed at readers who do not have an extensive background in those academic subjects of engineering, physics & mathematics - *several excerpts from Wikipedia are included in the Method section of this full-text article.*

The first step is to collect the output data or symptom ***(strain*** or ***ε)*** on a time scale. The second step is to calculate the output change rate with time ***(dε/dt)***, i.e. the change rate of strain or symptom over each period. The third step is to gather the input data or cause ***(viscosity or η)*** on a time scale. The fourth step is to calculate the time-dependent input or cause (time-dependent ***stress*** or ***σ***) by multiplying ***dε/dt*** and ***η*** together. ***The "time-dependent input or cause equation" of "stress σ = strain change rate of dε/dt * viscosity η" is the essential part of "time-dependency".*** The fifth step is to plot the input-output (i.e. stress-strain or cause-symptom) curve in a 2-dimensional space domain or SD (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 stress-strain curves or input-output curves (i.e. the hysteresis loops), which is also an indicator of associated energies (either created energy or dissipated energy) of this input and output dataset. These energy values can also be considered as the degrees of influence on output by inputs. The seventh step is assembly the area values of selected time-period in order to compare the "progression and contribution of condition" over certain time-periods.

For the frequency domain, the eighth step is ***to define a "hybrid input variable" by using "strain*stress" which yields another accurate estimation of energy ratio similar to the SD-VGT energy ratio associated with the hysteresis loop.*** The ninth step is to present these hybrid models' results of (strain*stress) in a TD and then perform the FFT operation to convert them into an FD. The enclosed area of the frequency curve (where the x-axis is the frequency and the y-axis is the amplitude of energy) can be used to estimate the total FD-FFT energy. The tenth step is to compare these FD energy results against the SD-VGT energy results.

After providing the above 10-step description, the author would still like to use the following set of ***VGT stress-strain mathematical equations*** in a two-dimensional SD to address the unique ***"time-dependency characteristics"*** of selected medical variables:

Strain
= ε
= individual strain value at the present time duration

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

Some of these inputs (causes or viscosity factors) are further normalized by dividing them or being divided by a normalization factor using certain established health standards, such as 1.0 for metabolism index where mi, i=1,10 for both 4 medical conditions and 6 lifestyle details since mi values have already been normalized in their original calculations. Other examples of normalization factors are 6.0 for HbA1C, 6 or 7 hours for night-time sleep hours, 120 mg/dL for glucose, 25 for body mass index (BMI), 4,000 steps after each meal, 10,000 or 12,000 steps for daily walking exercise depends on time-period selection, 15 or 20 grams of carbs/sugar intake amount per meal depends on time-period selection. If using the originally collected data, i.e. the non-normalized data, it would distort the numerical comparison of the hysteresis loop areas. ***Using this "normalization process", we can remove the dependency of the individual unit or certain unique characteristics associated with each viscosity factor.*** *This process allows us to convert the originally collected variables into a set of* ***"dimensionless variables"*** *for easier numerical comparison and result interpretation.*

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 counterpart is "when cause or risk factors are reduced or removed, the symptoms of the 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 temperatures, display significant viscoelastic effects. In some applications, even a small viscoelastic response can be significant.

Medical analogy

Viscoelastic behavior means the material has "time-dependent" characters. Biomedical data, i.e. biomarkers, are time-dependent due to body cells being 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 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 causing force is applied to it.

The following brief introductions are excerpts from Wikipedia:

"Elasticity (physics):

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 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 ma-

terial 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.

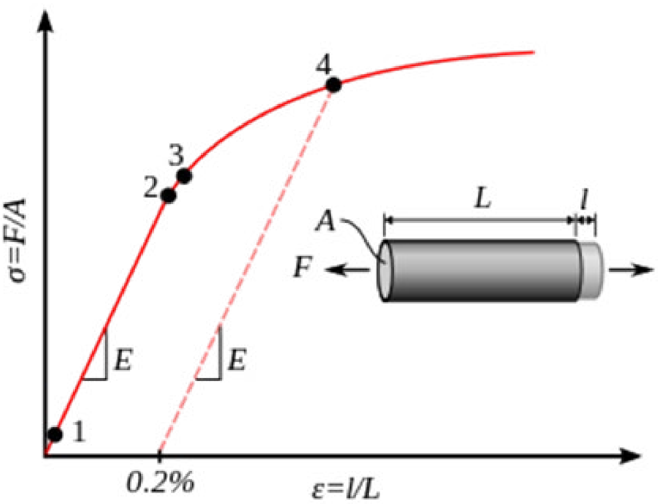
Medical analogy

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 in its original length, similar to a non-diabetes person or less-severed type 2 diabetes (T2D) patient.

Plasticity (physics)

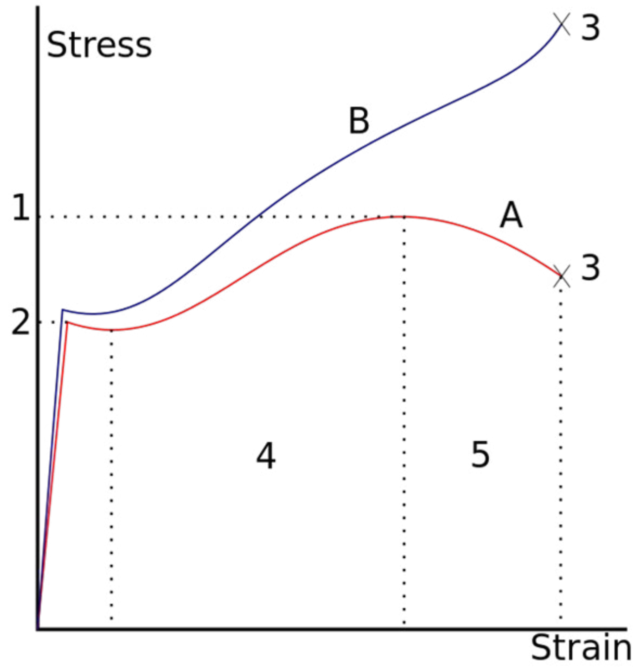
Deformation of a solid material undergoing non-reversible changes of shape in response to applied forces.

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 the 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 the 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 brought down to a healthy level of PPG even with a significant amount of exercise. This means that the PPG level has exceeded its "elastic limit" and entered 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 the 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.**

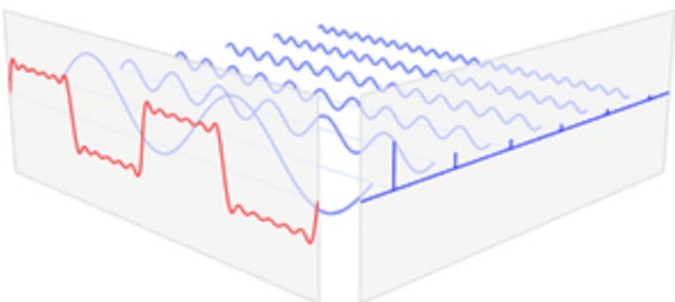
Viscoplasticity
Viscoplasticity is a theory in continuum mechanics that describes the rate-dependent inelastic behavior of solids. Rate-dependence in this context means that the deformation of the material depends on the rate at which loads are applied. The inelastic behavior that is the subject of viscoplasticity 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)
= dε/dt * η

The hysteresis loop area
= the integrated area of stress (σ) and strain (ε) curve
= ∮σdε

From Time domain to Frequency domain via Fourier Transform:
In physics, electronics, control systems engineering, and statistics, the frequency domain refers to the analysis of mathematical functions or signals with respect to frequency, rather than time. [1] Put simply, a time-domain graph shows how a signal changes over time, whereas a frequency-domain graph shows how much of the signal lies within each given frequency band over a range of frequencies. A frequency-domain representation can also include information on the phase shift that must be applied to each sinusoid in order to be able to recombine the frequency components to recover the original time signal.



The Fourier transform converts the function's time-domain representation, shown in red, to the function's frequency-domain representation, shown in blue. The component frequencies, spread across the frequency spectrum, are represented as peaks in the frequency domain.

A given function or signal can be converted between the time and frequency domains with a pair of mathematical operators called transforms. An example is the Fourier transform, which converts a time function into a complex valued sum or integral of sine waves of different frequencies, with amplitudes and phases, each of which represents a frequency component. The "spectrum" of frequency components is the frequency-domain representation of the signal. The inverse Fourier transform converts the frequency-domain function back to the time-domain function. A spectrum analyzer is a tool commonly used to visualize electronic signals in the frequency domain.

Advantages

One of the main reasons for using a frequency-domain representation of a problem is to simplify the mathematical analysis. For mathematical systems governed by linear differential equations, a very important class of systems with many real-world applications, converting the description of the system from the time domain to a frequency domain converts the differential equations to algebraic equations, which are much easier to solve.

In addition, looking at a system from the point of view of frequency can often give an intuitive understanding of the qualitative behavior of the system, and a revealing scientific nomenclature has grown up to describe it, characterizing the behavior of physical systems to time varying inputs using terms such as bandwidth, frequency response, gain, phase shift, resonant frequencies, time constant, resonance width, damping factor, Q factor, harmonics, spectrum, power spectral density, eigenvalues, poles, and zeros.

An example of a field in which frequency-domain analysis gives a better understanding than time domain is music; the theory of operation of musical instruments and the musical notation used to record and discuss pieces of music is implicitly based on the breaking down of complex sounds into their separate component frequencies (musical notes).

Magnitude and Phase

In using the Laplace, Z-, or Fourier transforms, a signal is described by a complex function of frequency: the component of the signal at any given frequency is given by a complex number. The modulus of the number is the amplitude of that component, and the argument is the relative phase of the wave. For example, using the Fourier transform, a sound wave, such as human speech, can be broken down into its component tones of different frequencies, each represented by a sine wave of a different amplitude and phase. The response of a system, as a function of frequency, can also be described by a complex function. In many applications, phase information is not important. By discarding the phase information, it is possible to simplify the information in a frequency-domain representation to generate a frequency spectrum or spectral density. A spectrum analyzer is a device that displays the spectrum, while the time-domain signal can be seen on an oscilloscope.

Types

Although "the" frequency domain is spoken of in the singular, there are a number of different mathematical transforms which are used to analyze time-domain functions and are referred to as "frequency domain" methods. These are the most common transforms, and the fields in which they are used:

- Fourier series – periodic signals, oscillating systems.
- Fourier transform – aperiodic signals, transients.
- Laplace transform – electronic circuits and control systems.
- Z transform – discrete-time signals, digital signal processing.
- Wavelet transform — image analysis, data compression.

More generally, one can speak of the transform domain with respect to any transform. The above transforms can be interpreted as capturing some form of frequency, and hence the transform domain is referred to as a frequency domain.

Discrete Frequency Domain

The Fourier transform of a periodic signal has energy only at a base frequency and its harmonics. Another way of saying this is that a periodic signal can be analyzed using a discrete frequency domain. Dually, a discrete-time signal gives rise to a periodic frequency spectrum. Combining these two, if we start with a time signal which is both discrete and periodic, we get a frequency spectrum which is also both discrete and periodic. This is the usual context for a discrete Fourier transform.

History of Term

The use of the terms "frequency domain" and "time domain" arose in communication engineering in the 1950s and early 1960s, with "frequency domain" appearing in 1953. See time domain: origin of term for details.

Results

Figure 1 shows the data table and time-domain observed results.

8/2/22	Strain	N. m1	N. m5	N. m9b	Strain Rate	Strain	Stress 1	Stress 2	Stress 3	Height 1	Height 2	Height 3	Area 1	Area 2	Area 3			FD 1	FD 2	FD 3
Excel	Cancer Risk	Weight	Exercise	Food Quality	Cancer Rate	Cancer	Weight	Exercise	Food	Weight	Exercise	Food	Weight	Exercise	Food	Period #	Period %	Weight	Exercise	Food
Y2012	57	1.24	1.71	1.00	0	57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0	0	0
Y2013	53	1.12	1.22	0.80	-4	53	-4.48	-4.88	-3.20	-2.24	-2.44	-1.60	8.96	9.76	6.40			-237	-259	-170
Y2014	50	1.05	0.89	0.60	-3	50	-3.15	-2.67	-1.80	-3.82	-3.78	-2.50	11.45	11.33	7.50	Y12-Y15		-158	-134	-90
Y2015	46	1.05	0.70	0.55	-4	46	-4.20	-2.80	-2.20	-3.68	-2.74	-2.00	14.70	10.94	8.00	89.03	71%	-193	-129	-101
Y2016	43	1.02	0.62	0.55	-3	43	-3.06	-1.86	-1.65	-3.63	-2.33	-1.93	10.89	6.99	5.78			-132	-80	-71
Y2017	41	1.04	0.59	0.52	-2	41	-2.08	-1.18	-1.04	-2.57	-1.52	-1.35	5.14	3.04	2.69			-85	-48	-43
Y2018	42	1.02	0.61	0.51	1	42	1.02	0.61	0.51	-0.53	-0.29	-0.27	-0.53	-0.29	-0.27	Y16-Y19		43	26	21
Y2019	42	1.02	0.69	0.50	0	42	0.00	0.00	0.00	0.51	0.31	0.26	0.00	0.00	0.00	33.45	27%	0	0	0
Y2020	41	1.01	0.64	0.50	-1	41	-1.01	-0.64	-0.50	-0.51	-0.32	-0.25	0.51	0.32	0.25			-41	-26	-21
Y2021	40	1.00	0.73	0.50	-1	40	-1.00	-0.73	-0.50	-1.01	-0.69	-0.50	1.01	0.69	0.50	Y20-Y22		-40	-29	-20
Y2022	40	1.01	0.72	0.50	0	40	0.00	0.00	0.00	-0.50	-0.37	-0.25	0.00	0.00	0.00	3.27	3%	0	0	0
Average	45.00	1.05	0.83	0.59	-1.55	45.00	-1.63	-1.29	-0.94	-1.63	-1.29	-0.94	52	43	31	125.74	FD Energy	91912	78171	36408
Eneegy Ratio		52%	32%	16%			42%	33%	24%	42%	33%	24%	41%	34%	25%	100%	FD Ratio	45%	38%	18%
TD Energy (sq)		1.11	0.69	0.35																
Correlation	100%	91%	91%	93%																

Figure 1: Data table and Time-domain analysis results

Figure 2 depicts the space-domain VGT stress-strain analysis results and frequency-domain FFT analysis results of breast cancer prevention versus body weight, daily exercise, and food quality.

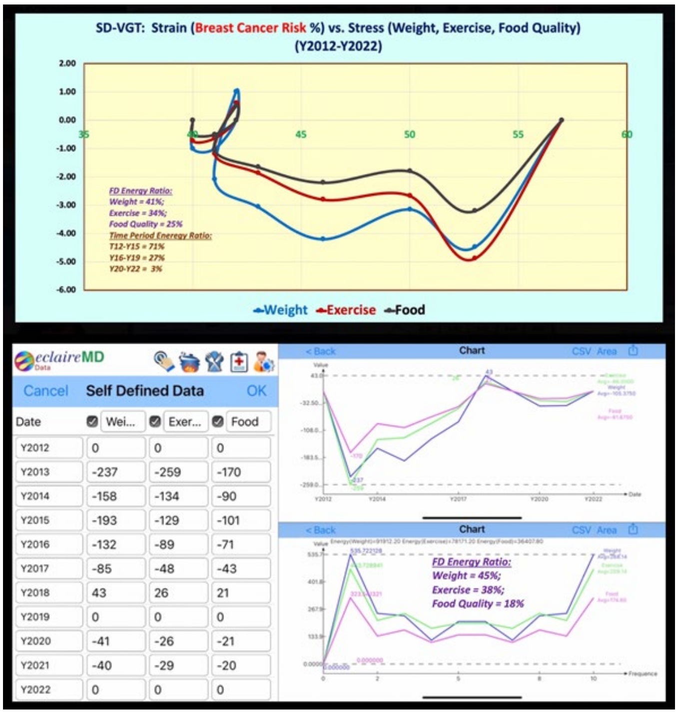


Figure 2: Results from Space-domain VGT energy analysis and Frequency-domain FFT energy analysis

Figure 3 illustrates the food quality list the author selected (very similar to a Mediterranean diet).

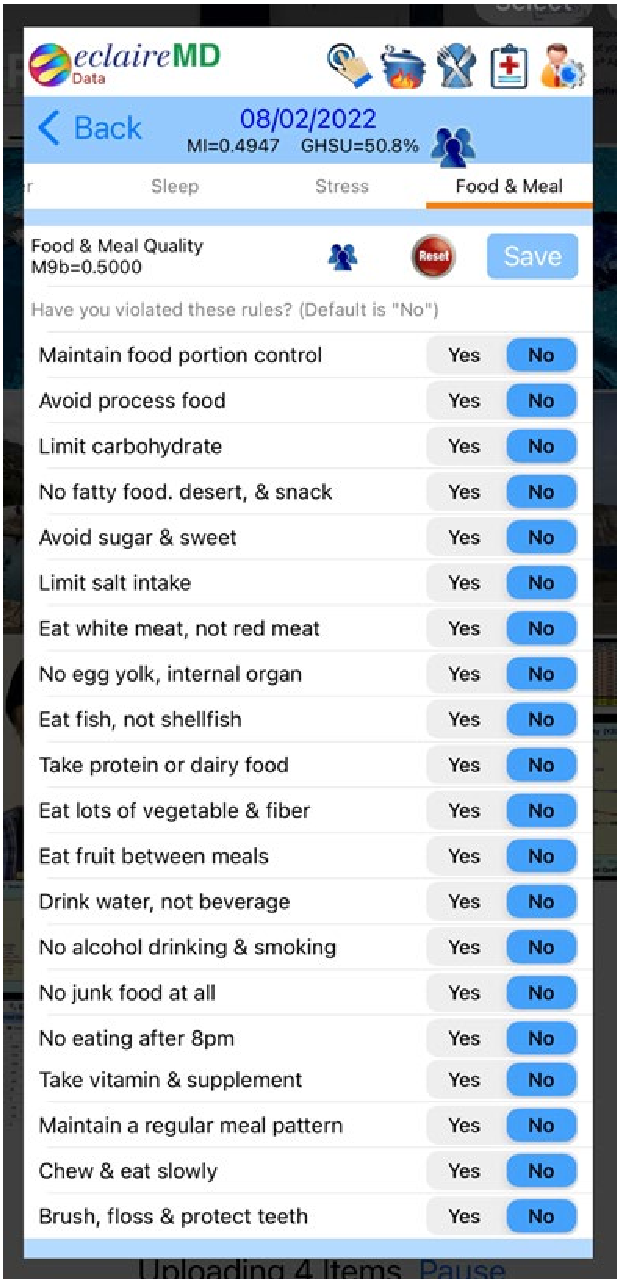


Figure 3: Food quality list

Conclusions

In summary, there are 5 observations from this prevention analysis of lowering breast cancer risk probability % versus 3 important lifestyle details, weight control, daily exercise, and food quality, using 3 different MPM approaches, TD, SD-VGT, and FD-FFT.

1. From the TD analysis of 11 annual data, ***the energy (squared amplitude) ratios are: weight = 52%, exercise = 32%, and Food quality = 16%.*** *The TD energy raking order is* ***weight > exercise > food quality*** *which is resulted from the fact of* ***"degree of control is in a reversed order of food quality being the highest, exercise being in the middle, and weight control being the lowest"****.*
2. In SD-VGT energy analysis of stress-strain diagrams, *the*

cancer risk has the following ***energy contribution ratios: weight = 41%; exercise = 34%; food quality = 25%.*** *This observed phenomenon results from the* ***average weight (1.05) being higher than the average exercise score (0.83), and then further higher than the average food score (0.59)***. The higher average value of viscosity creates a higher stress value (with the same strain rate), leading to a higher height of hysteresis loop area (the base of hysteresis loop area is the strain rate), and then, a larger size of the hysteresis loop area.

3. In SD-VGT ***time-period*** *energy contribution analysis results, the cancer risk % has the following* ***time-period energy contribution ratios: Y12-Y15 = 71%; Y16-Y19 = 27%; Y20-Y22 = 3%.*** *In other words,* ***most of the 3 influential amounts on breast cancer risk probability occurred during the earlier period of Y2012-Y2015.***
4. In FD-FFT energy analysis results, *the cancer risk has the following* ***FD energy contribution ratios: weight = 45%; exercise = 38%; food quality = 18%.***
5. ***The energy distribution ratios using 3 different tools, i.e. TD-squared amplitude, SD-VGT, and FD-FFT, are quite similar to each other.***

This article is simply to analyze the degree of influence for three specific inputs on breast cancer prevention. *The author is not capable of precisely predicting the future outlook of any cancer occurrence. The only thing we can do is to increase the probability of avoiding cancers.* ***However, the more we understand each influential factor's contribution to breast cancer, the better prevention efforts can be done.*** These specific energy methods of TD, SD, and FD are different scientific methods using disciplines from mathematics, physics, and engineering to investigate cancers. They can provide some useful guidance to achieve the ultimate goal of lowering the risk probability of developing various cancers, including breast cancer, to avoid death.

References

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

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