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Research Article

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Psychological Behaviors and Pathophysiological Characteristics of a Diabetes Patient using Space-Domain Analysis and Viscoplastic Energy Model in GH-Method: Math-Physical Medicine (No. 1021, Viscoelastic Medicine Theory #419)

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Abstract

A patient's management of type 2 diabetes (T2D) through lifestyle choices is intricately connected to his/her understanding of diet and exercise, specifically food nutrition, as well as psychological traits such as determination, willpower, and persistence. Unlike taking medications, which is simple and easy, adhering to a diet and exercise regimen demands a comprehensive knowledge of food nutrition and strong persistence to maintain a routine over the long term to achieve positive results.

This paper investigates the relationship between hemoglobin A1C (HbA1C or A1C) levels and five input factors: body weight (BW), fasting glucose (FPG), post-meal glucose (PPG), carbohydrate and sugar intake grams (carbs), and post-meal walking steps (steps).

The analysis leverages personal data collected by the author since 2010. Data collection began on January 1, 2010, with limited data available. However, daily data collection, including each meal, commenced on May 1, 2015.

The first part of this study compares the psychological behaviors with the pathophysiological changes in both A1C and carbs/steps over the past 15 years using a two-dimensional space-domain analysis. The second part of this study, focusing on viscoplastic energy, utilizes the most recent 10 years of collected data.

***In summary,** the initial part of this study reveals a significant disparity in carbohydrate/sugar intake (on the x-axis) and walking steps (on the y-axis) between 2010-2014 and 2015-2024. During the first five years, the author's average carbohydrate intake was high, and walking steps were low, indicating a lack of understanding of food nutrition and inadequate engagement in exercise. This is reflected in his A1C levels, demonstrating the impact of his diet and exercise. These trends are clearly depicted in the two-dimensional space-domain chart for the initial five years. Post-2015, the chart illustrates a smaller, more concentrated area, signifying a stronger correlation between the author's psychological behavior, nutritional knowledge, and pathophysiological characteristics, leading to consistently lower HbA1C levels (below 7%).*

In the subsequent part of this study, the viscoplastic energy ratios are:

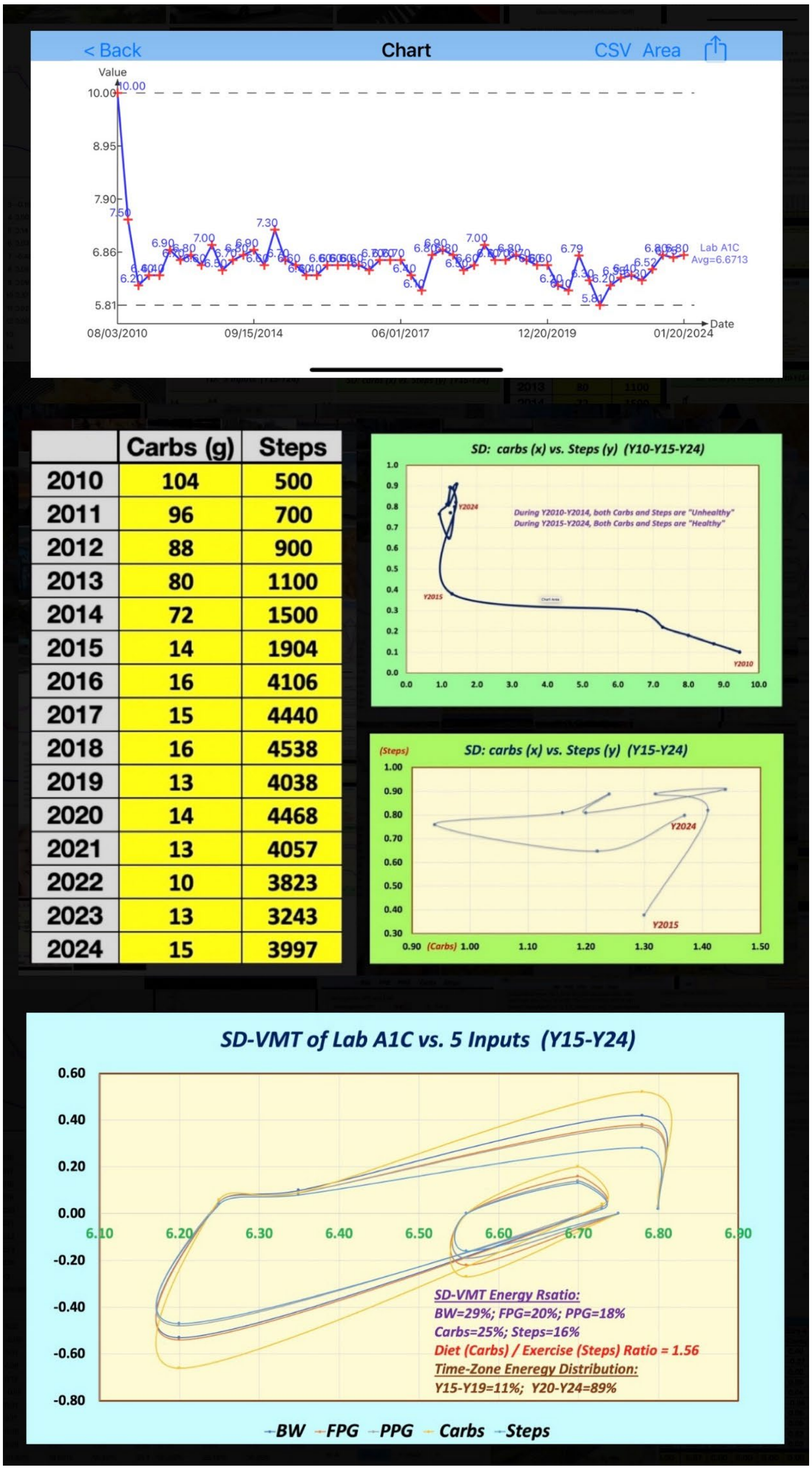
BW = 29%
FPG = 20%
PPG = 18%
Carbs = 25%
Steps = 16%

The body weight significantly affects FPG, serving as a measure of insulin resistance from pancreatic beta

cells and forming a baseline for daily PPG levels. The combined influence of BW, FPG, and PPG contributes to approximately 60% of total A1C formation, with lifestyle choices such as diet and exercise accounting for the remaining 40%.

The ratio between carbohydrates (influencing all 8 pathophysiological pathways of diabetes) and steps (influencing 5 pathophysiological pathways of diabetes) is 1.6 (25% divided by 16%), indicating that diet plays a more substantial role than exercise in A1C formation and diabetes control.

Key Message
The author adeptly merges the disciplines of mathematics, physics, and engineering with considerations of psychological behaviors and diabetes pathophysiology of the patient.



	Carbs (g)	Steps
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2013	80	1100
2014	72	1500
2015	14	1904
2016	16	4106
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2018	16	4538
2019	13	4038
2020	14	4468
2021	13	4057
2022	10	3823
2023	13	3243
2024	15	3997

1. Introduction

A patient's management of type 2 diabetes (T2D) through lifestyle choices is intricately connected to his/her understanding of diet and exercise, specifically food nutrition, as well as psychological traits such as determination, willpower, and persistence. Unlike taking medications, which is simple and easy, adhering to a diet and exercise regimen demands a comprehensive knowledge of food nutrition and strong persistence to maintain a routine over the long term to achieve positive results.

This paper investigates the relationship between hemoglobin A1C (HbA1C or A1C) levels and five input factors: body weight (BW), fasting glucose (FPG), post-meal glucose (PPG), carbohydrate and sugar intake grams (carbs), and post-meal walking steps (steps).

The analysis leverages personal data collected by the author since 2010. Data collection began on January 1, 2010, with limited data available. However, daily data collection, including each meal, commenced on May 1, 2015.

The first part of this study compares the psychological behaviors with the pathophysiological changes in both A1C and carbs/steps over the past 15 years using a two-dimensional space-domain analysis. The second part of this study, focusing on viscoplastic energy, utilizes the most recent 10 years of collected data.

1.1 Biomedical and Engineering information

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

"The relationship between the psychological behaviors of being willing to learn new knowledge about food and diet and exercise, and the pathophysiological characteristics of diabetes, such as HbA1C, is complex and multifaceted.

Psychological behaviors, such as the willingness to learn new knowledge about food and diet, can significantly impact an individual's ability to manage their diabetes. A positive attitude towards learning about nutrition and making healthy dietary choices can lead to better blood sugar control and overall health. Similarly, a proactive approach to physical activity and exercise can also have a positive impact on diabetes management by improving insulin sensitivity, reducing blood sugar levels, and promoting overall well-being.

The physiological impact of these psychological behaviors is reflected in measures such as HbA1C, which provides valuable insight into a person's average blood sugar levels over a period of time. A willingness to learn about food and diet, and regular exercise can contribute to better HbA1C levels, indicating improved diabetes management and reduced risk of long-term complications.

It's important to note that while psychological behaviors play a significant role, they are just one aspect of diabetes management. Treatment plans for diabetes often encompass a holistic approach that includes medication, nutrition, physical activity, and psychological support.

Overall, the relationship between psychological behaviors related to learning about food and exercise and pathophysiological characteristics of diabetes, such as HbA1C, underscores the importance of a proactive and informed approach to diabetes care that considers both the psychological and physiological factors involved."

2. MPM Background

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

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

3. The Author'S Diabetes History

The author was a severe T2D patient since 1995. He weighed 220 lb. (100 kg) at that time. By 2010, he still weighed 198 lb. with an average daily glucose of 250 mg/dL (HbA1C at 10%). During that year, his triglycerides reached 1161 (high risk for CVD and stroke) and his albumin-creatinine ratio (ACR) at 116 (high risk for chronic kidney disease). He also suffered from five cardiac episodes within a decade. In 2010, three independent physicians warned him regarding the need for kidney dialysis treatment and the future high risk of dying from his severe diabetic complications.

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

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

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

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

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

4. Energy theory

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

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

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

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

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

Time-dependent output strain and stress of (viscous input*output rate)

Hooke's law of linear elasticity is expressed as:

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

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

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

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

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

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

Where strain is expressed as Greek epsilon or ε.

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

Strain
= (body weight at certain specific time instant)

He also calculates his strain rate using the following formula:

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

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

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

5. Results

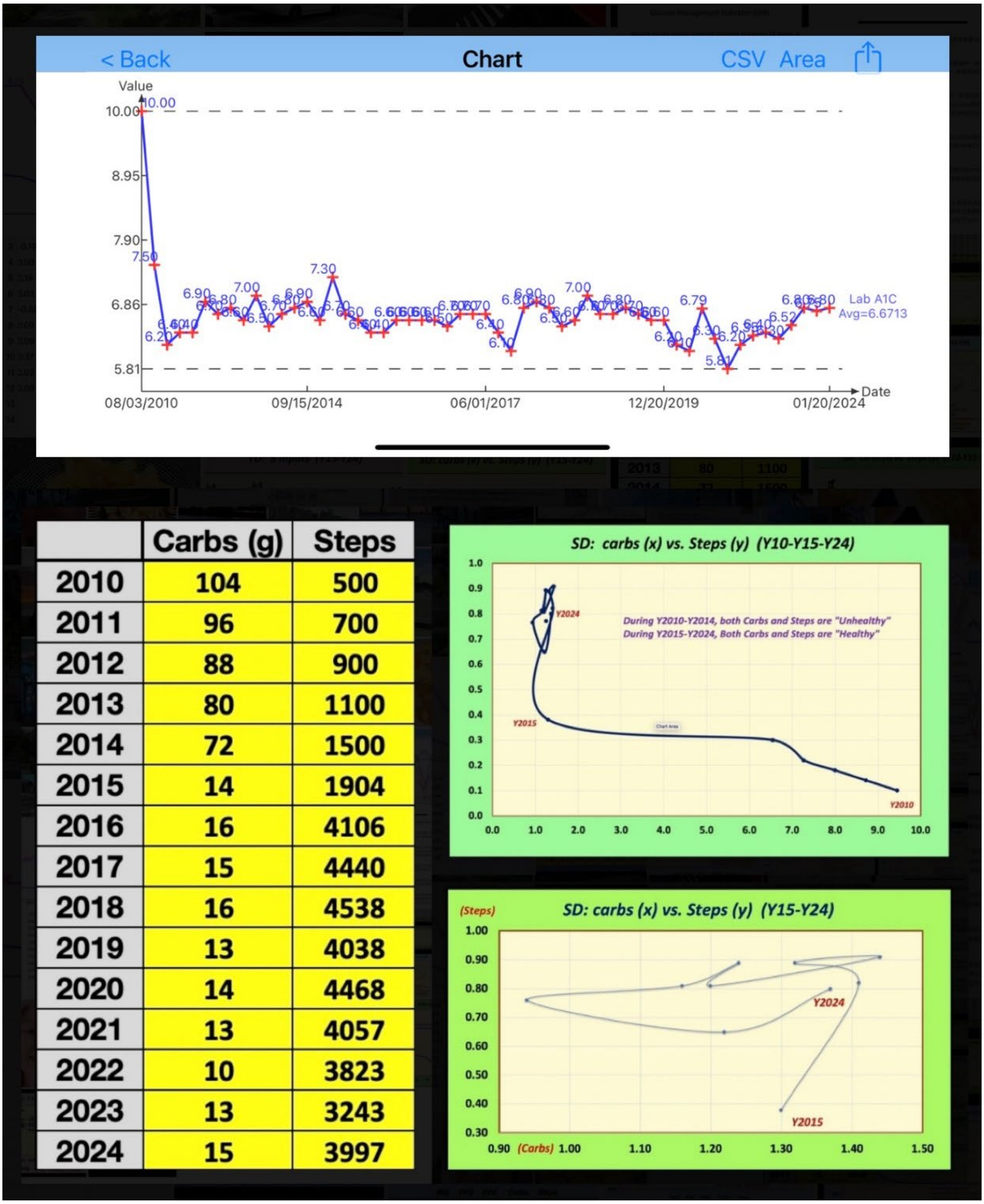

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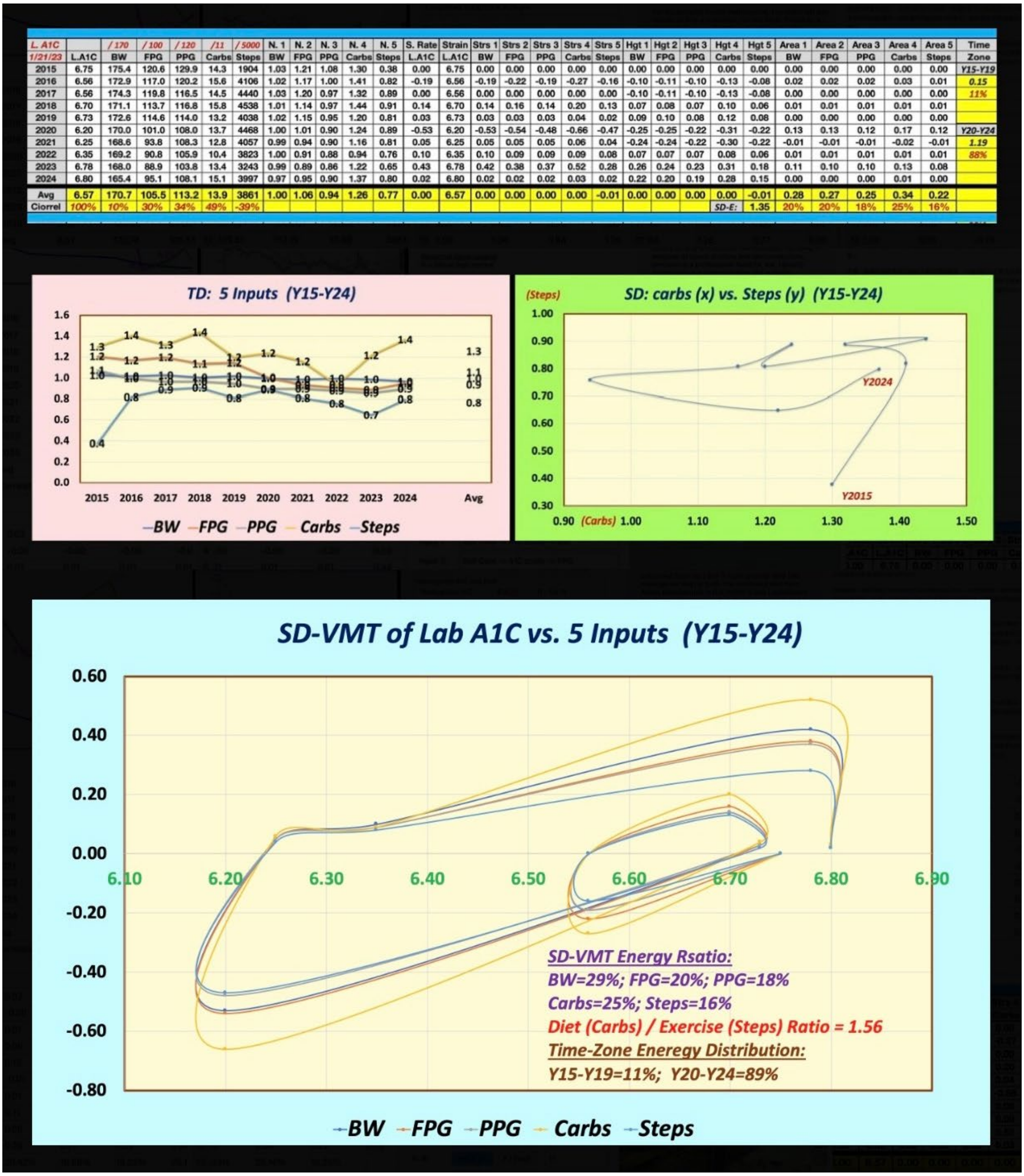
Figure 1: Results from first study



L. A1C 1/21/23	L.A1C	/170 BW	/100 FPG	/120 PPG	/11 Carbs	/5000 Steps	N. 1 BW	N. 2 FPG	N. 3 PPG	N. 4 Carbs	N. 5 Steps	S. Rate L.A1C
2015	6.75	175.4	120.6	129.9	14.3	1904	1.03	1.21	1.08	1.30	0.38	0.00
2016	6.56	172.9	117.0	120.2	15.6	4106	1.02	1.17	1.00	1.41	0.82	-0.19
2017	6.56	174.3	119.8	116.5	14.5	4440	1.03	1.20	0.97	1.32	0.89	0.00
2018	6.70	171.1	113.7	116.8	15.8	4538	1.01	1.14	0.97	1.44	0.91	0.14
2019	6.73	172.6	114.6	114.0	13.2	4038	1.02	1.15	0.95	1.20	0.81	0.03
2020	6.20	170.0	101.0	108.0	13.7	4468	1.00	1.01	0.90	1.24	0.89	-0.53
2021	6.25	168.6	93.8	108.3	12.8	4057	0.99	0.94	0.90	1.16	0.81	0.05
2022	6.35	169.2	90.8	105.9	10.4	3823	1.00	0.91	0.88	0.94	0.76	0.10
2023	6.78	168.0	88.9	103.8	13.4	3243	0.99	0.89	0.86	1.22	0.65	0.43
2024	6.80	165.4	95.1	108.1	15.1	3997	0.97	0.95	0.90	1.37	0.80	0.02
Avg	6.57	170.7	105.5	113.2	13.9	3861	1.00	1.06	0.94	1.26	0.77	0.00
Ciorrel	100%	10%	30%	34%	49%	-39%						

L. A1C 1/21/23	Strain L.A1C	Strs 1 BW	Strs 2 FPG	Strs 3 PPG	Strs 4 Carbs	Strs 5 Steps	Hgt 1 BW	Hgt 2 FPG	Hgt 3 PPG	Hgt 4 Carbs	Hgt 5 Steps	Area 1 BW	Area 2 FPG	Area 3 PPG	Area 4 Carbs	Area 5 Steps	Time Zone
2015	6.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Y15-Y19
2016	6.56	-0.19	-0.22	-0.19	-0.27	-0.16	-0.10	-0.11	-0.10	-0.13	-0.08	0.02	0.02	0.02	0.03	0.01	0.15
2017	6.56	0.00	0.00	0.00	0.00	0.00	-0.10	-0.11	-0.10	-0.13	-0.08	0.00	0.00	0.00	0.00	0.00	11%
2018	6.70	0.14	0.16	0.14	0.20	0.13	0.07	0.08	0.07	0.10	0.06	0.01	0.01	0.01	0.01	0.01	
2019	6.73	0.03	0.03	0.03	0.04	0.02	0.09	0.10	0.08	0.12	0.08	0.00	0.00	0.00	0.00	0.00	
2020	6.20	-0.53	-0.54	-0.48	-0.66	-0.47	-0.25	-0.25	-0.22	-0.31	-0.22	0.13	0.13	0.12	0.17	0.12	Y20-Y24
2021	6.25	0.05	0.05	0.05	0.06	0.04	-0.24	-0.24	-0.22	-0.30	-0.22	-0.01	-0.01	-0.01	-0.02	-0.01	1.19
2022	6.35	0.10	0.09	0.09	0.09	0.08	0.07	0.07	0.07	0.08	0.06	0.01	0.01	0.01	0.01	0.01	88%
2023	6.78	0.42	0.38	0.37	0.52	0.28	0.26	0.24	0.23	0.31	0.18	0.11	0.10	0.10	0.13	0.08	
2024	6.80	0.02	0.02	0.02	0.03	0.02	0.22	0.20	0.19	0.28	0.15	0.00	0.00	0.00	0.01	0.00	
Avg	6.57	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01	0.28	0.27	0.25	0.34	0.22	
Ciorrel										SD-E:	1.35	20%	20%	18%	25%	16%	

Figure 2: Results from second study

6. Conclusions

In summary, the initial part of this study reveals a significant disparity in carbohydrate/sugar intake (on the x-axis) and walking steps (on the y-axis) between 2010-2014 and 2015-2024. During the first five years, the author's average carbohydrate intake was high, and walking steps were low, indicating a lack of understanding of food nutrition and inadequate engagement in exercise. This is reflected in his A1C levels, demonstrating the impact of his diet and exercise. These trends are clearly depicted in the two-dimensional space-domain chart for the initial five years. Post-2015, the chart illustrates a smaller, more concentrated area, signifying a stronger correlation between the author's psychological behavior, nutritional knowledge, and pathophysiological characteristics, leading to consistently lower HbA1C levels (below 7%).

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Key Message

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References

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