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Research Article

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Applying Lifestyle Pattern Analysis and Glucose/Exercise Segmentation Analysis to Study the Impacts of Hot Summer Weather on Exercise and Busy Traveling Lifestyle on Postprandial Plasma Glucose During a 3.4-Year Period from 5/8/2018 to 8/29/2021 Based on GH-Method: Math-Physical Medicine (No. 504)

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Abstract

Since 1/1/2012, the author measured his postprandial plasma glucose (PPG) using the finger-piercing method three times a day at two hours after the first bite of his meals. After eating each meal, he normally walks around 4,000 steps from 1 to 1.5 hours post-meal. Since 5/5/2018, he applied a continuous glucose monitoring (CGM) sensor device on his upper arm and collected glucose data constantly at 15-minute time intervals and then recorded the complete data on his iPhone. As a result, he has been accumulating 13 glucose values for each PPG at 3-hour periods and 96 glucose data each day over the past 3.4 years from 5/8/2018 to 8/29/2021.

By early 2019, he noticed that most of his daily sensor PPG waveforms have had similar shapes. They usually appeared as a mountain shape with its peak at various heights around 60-minutes post-meal and then they would start to decline for another hour. This means that his PPG curve usually reaches to its peak approximately 60-minutes and then drops to its nadir around 120-minutes. After 120-minutes, if he stops walking, sometimes his PPG curve would start to tilt upward again, but the PPG curve would remain flat at nadir position for most of the remaining time. Either remaining as a flat line or moving ahead with a smaller slope to reach to another lower peak near 180-minutes are considered significant biophysical phenomena of PPG biomedical behavior. After noticing this biophysical phenomenon of glucose waves, he started to research and analyze them with the energy theory and wave theory which he learned from academic disciplines such as mechanical engineering, structural engineering and electronic engineering. As a result, he started to utilize the concept of the energy balance between infusion and consumption that would result at either an energy equilibrium or disequilibrium situation. This state of energy balance from engineering are related to the mass-energy equivalence theory such as theory of relativity of quantum mechanics. Furthermore, the above-mentioned situations are extremely similar to the biomedical condition of metabolism in medicine. These learned knowledge and research findings lead him into an expanded scope of the damage created on internal organs through excessive energy, i.e., when the energy infusion from food is greater than the energy consumption by exercise and other factors.

As a result, he intends to use the collected personal data (2+ million data) over the past 10 years and his developed GH-Method: math-physical medicine to confirm some of the excellent descriptions and conclusions from the 8 intra-cellular pathological process & pathways cited from Chapter 7 by Dr. Robert H. Lustig (Reference 1). Essentially, the author uses his collected big data and applies his learned disciplines such as mathematics, physics, and engineering to prove the outstanding biomedical descriptions using cell-biology and chemistry by Dr. Lustig.

In this article, the author utilizes the sensor glucose collection period from 5/8/2018 to 8/29/2021 as the baseline model to investigate two key areas:
the summer hot weather's impact on his exercises routines and the busy traveling schedule and its associated lifestyle's impact on PPG levels.

In summary, the summer's hot ambient temperature has caused him to unwillingly walk outside under the sun. This physical reaction and psychological feeling have decreased his overall daily walking steps and post-lunch walking steps by around 3% to 5%. In theory, this rather small reduction on exercise could increase his PPG level upward a little; however, in reality, the overall lifestyle would exponentially affect his PPG level.

During the period of 2018-2019, the author traveled through 50 international and US domestic cities, attended 65+ medical conferences, and made 120+ oral presentations. Under this kind of lifestyle pressure involving heavy business travel, such as catching airline flights, eating in restaurants, unable to avoid processed foods, finding suitable environment for walking, disturbing sleep schedules by jet-leg, and stress from different meeting events, would severely interrupt his normal regular life routines and then damage his health. Therefore, the results from his lifestyle pattern analysis and PPG segmentation analysis have shown two "graphical lumps" which are beyond 130 mg/dL in 90-days moving average case and beyond 140 mg/dL in daily PPG data case during the period of 5/8/2018 to 1/15/2010. Another interesting contrast is that his PPG levels are much lower and below 130 mg/dL level during the "COVID-19 self-quarantine" period from 1/19/2020 to 8/29/2021. Observation from this case study demonstrates that overall lifestyle, particularly food quality, has impacted glucoses more than the exercise factor alone. The above findings have also confirmed the statements of the 8 metabolic disorder's intra-cellular pathological pathways by Dr. Lustig (see Method section and Reference 1).

Introduction

Since 1/1/2012, the author measured his postprandial plasma glucose (PPG) using the finger-piercing method three times a day at two hours after the first bite of his meals. After eating each meal, he normally walks around 4,000 steps from 1 to 1.5 hours post-meal. Since 5/5/2018, he applied a continuous glucose monitoring (CGM) sensor device on his upper arm and collected glucose data constantly at 15-minute time intervals and then recorded the complete data on his iPhone. As a result, he has been accumulating 13 glucose values for each PPG at 3-hour periods and 96 glucose data each day over the past 3.4 years from 5/8/2018 to 8/29/2021.

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In this article, the author utilizes the sensor glucose collection period from 5/8/2018 to 8/29/2021 as the baseline model to investigate two key areas:

the summer hot weather's impact on his exercises routines and the busy traveling schedule and its associated lifestyle's impact on PPG levels.

Methods

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 ~500 medical papers.

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

The Author'S Case of Diabetes and Complications

The author has been a severe T2D patient since 1996. He weighed 220 lb. (100 kg, BMI 32.5) at that time. By 2010, he still weighed 198 lb. (BMI 29.2) with an average daily glucose of 250 mg/dL (HbA1C of 10%). During that year, his triglycerides reached to 1161 (diabetic retinopathy or DR) and albumin-creatinine ratio (ACR) at 116 (chronic kidney disease or CKD). He also suffered from five cardiac episodes within a decade. In 2010, three independent physicians warned him regarding his needs of kidney dialysis treatment and future high risk of dying from severe diabetic complications. Other than cerebrovascular disease (stroke), he has suffered most known diabetic complications, including both macro-vascular and micro-vascular complications.

In 2010, he decided to launch his self-study on endocrinology, diabetes, and food nutrition in order to save his own life. During 2015 and 2016, he developed four prediction models related to diabetes conditions: weight, PPG, fasting plasma glucose (FPG), and A1C. As a result, from using his developed mathematical metabolism index (MI) model in 2014 and the four prediction tools, by end of 2016, his weight was reduced from 220 lbs. (100 kg, BMI 32.5) to 176 lbs. (89 kg, BMI 26.0), waistline from 44 inches (112 cm, nonalcoholic fatty liver disease /NAFLD) to 33 inches (84 cm), average finger glucose reading from 250 mg/dL to 120 mg/dL, and lab-tested A1C from 10% to ~6.5%. One of his major accomplishments is that he no longer takes any diabetes medications since 12/8/2015.

In 2017, he has achieved excellent results on all fronts, especially his glucose control. However, during the pre-COVID period of 2018 and 2019, he traveled to approximately 50+ internation-

al cities to attend 65+ medical conferences and made ~120 oral presentations. This hectic schedule inflicted damage to his diabetes control, through dinning out frequently, post-meal exercise disruption, jet lag, and along with the overall metabolism impact due to his irregular life patterns through a busy travel schedule; therefore, his glucose control and overall metabolism state were somewhat affected during this two-year heavier traveling period.

During 2020 with a COVID-19 quarantined lifestyle, not only has he published ~400 medical papers in 100+ journals, but he has also reached his best health conditions for the past 26 years. By the beginning of 2021, his weight was further reduced to 165 lbs. (BMI 24.4) along with a 6.1% A1C value (daily average glucose at 105 mg/dL), without having any medication interventions or insulin injections. These good results are due to his non-traveling, low-stress, and regular daily life routines. Due to his knowledge of chronic diseases, practical lifestyle management experiences, and developed various high-tech tools contribute to his excellent health status since 1/19/2020, which is the start date of being self-quarantined.

On 5/5/2018, he applied a CGM sensor device on his upper arm and checks glucose measurements every 5 minutes for a total of ~288 times each day. He has maintained the same measurement pattern to present day. In his research work, he uses the CGM sensor glucose at time-interval of 15 minutes (96 data per day). By the way, the difference of average sensor glucoses between 5-minute intervals and 15-minute intervals is only 0.4% (average glucose of 114.81 mg/dL for 5-minutes and average glucose of 114.35 mg/dL for 15-minutes with a correlation of 93% between these two sensor glucose curves) during the period from 2/19/20- to 8/13/21.

Therefore, over the past 11 years, he could study and analyze the collected 2+ million data regarding his health status, medical conditions, and lifestyle details. He applies his knowledge, models, and tools from mathematics, physics, engineering, and computer science to conduct his medical research work. His medical research work is based on the aims of achieving both "high precision" with "quantitative proof" in the medical findings.

The following timetable provides a rough sketch of the emphasis of his medical research during each stage:

- 2000-2013: Self-study diabetes and food nutrition, developing a data collection and analysis software.
- 2014: Develop a mathematical model of metabolism, using engineering modeling and advanced mathematics.
- 2015: Weight & FPG prediction models, using neuroscience.
- 2016: PPG & HbA1C prediction models, using optical physics, artificial intelligence (AI), and neuroscience.
- 2017: Complications due to macro-vascular research such as CVD, coronary heart disease (CHD) and stroke, using pattern analysis and segmentation analysis.
- 2018: Complications due to micro-vascular research such as CKD, bladder, foot, and eye issues (DR).
- 2019: CGM big data analysis, using wave theory, energy theory, frequency domain analysis, quantum mechanics, and AI.
- 2020: Cancer, dementia, longevity, geriatrics, DR, hypothyroidism, diabetic foot, diabetic fungal infection, and linkage between metabolism and immunity, learning about certain infectious diseases, such as COVID-19.
- • 2021: Applications of linear elastic glucose theory (LEGT) and perturbation theory from quantum mechanics on medical research subjects, such as chronic diseases and their complications, cancer, and dementia. Using metabolism and immunity.it's as the base, he expands his research into cancers, semantic, and COVID-19.

Again, to date, he has collected more than two million data regarding his medical conditions and lifestyle details. In addition, he has written 498 medical papers and published 400+ articles in 100+ various medical journals, including 6 special editions with his 20-25 papers exclusively for each edition. Moreover, he has given ~120 presentations at ~65 international medical conferences. He has continuously dedicated time and effort on medical research work and shared his findings and learnings with other patients worldwide.

Excerpt from "Metabolical"

"The 8 intra-cellular or sub-cellular pathological processes (or pathways) are the basic causes of chronic diseases which are not mutually exclusive. Each interacts with the others, and so they tend to cluster together.

These 8 processes are:

(1) Glycation
(2) Oxidative stress
(3) Mitochondrial dysfunction
(4) Insulin resistance
(5) Cell membrane integrity & fluidity
(6) Inflammation
(7) Epigenetics, not genetic
(8) Cell autophage

All of these 8 pathologies are related to food and nutrition. *In order to maintain excellent health and avoid metabolic syndrome, we must consume real food with good nutrition.* ***Processed food must be avoided since they cause the most damage to the body and metabolism system.***

Food is related to all of the 8 pathologies. However, exercise is only related to 5 pathologies, *i.e., Mitochondrial dysfunction, Insulin resistance, Inflammation, Epigenetics, and Cell autophage;* ***exercise has no relationships with Glycation, Oxidative stress, Cell membrane integrity & fluidity.***

The key to fend off chronic diseases is to keep the eight intra-cellular pathological pathways running correctly.

Drugs and nutraceuticals don't work for metabolic syndrome. *All of the 8 pathologies are driven by and are responsive to specific components of real food, because real food gets where it needs to inside the cell.* ***Processed food*** *gets in and* ***poisons*** *the 8 pathways instead."*

Results

Figure 1 shows his daily and 3 post-meal walking K-steps for 3 different periods: 1/17/2017 to 8/29/2021 (a longer period with a complete set of exercise data), 1/19/2020 to 8/29/2021 (the COVID-19 quarantine period), and 5/8/2018 to 8/29/2021 (the sensor glucose data period). In these 3 different time-length periods, ***the post-lunch walking steps are always the smallest amount. This shows his reluctance to walk after lunch, under***

the sun, at least not as much compared to the other two post-meal exercise during summer.

Figure 2 depicts the segmentation analysis results of his daily walking steps <16,000 and his post-meal walking steps <3,500 for the sensor glucose data period from 5/8/2018 to 8/29/2021. The top 2 diagrams reflect the complete waveforms of both daily and post-meal walking steps. The bottom 2 reveals the daily walking steps which are <16,000 steps and the post-meal walking steps which are <3,500 steps. ***These two "graphical dips" in both diagrams match with two "summer" seasons. In order to compensate the possible PPG rising via less amount of exercise, he would eat less, have more soup meals, and/or practice intermittent fasting in order to reduce his energy infusion.***

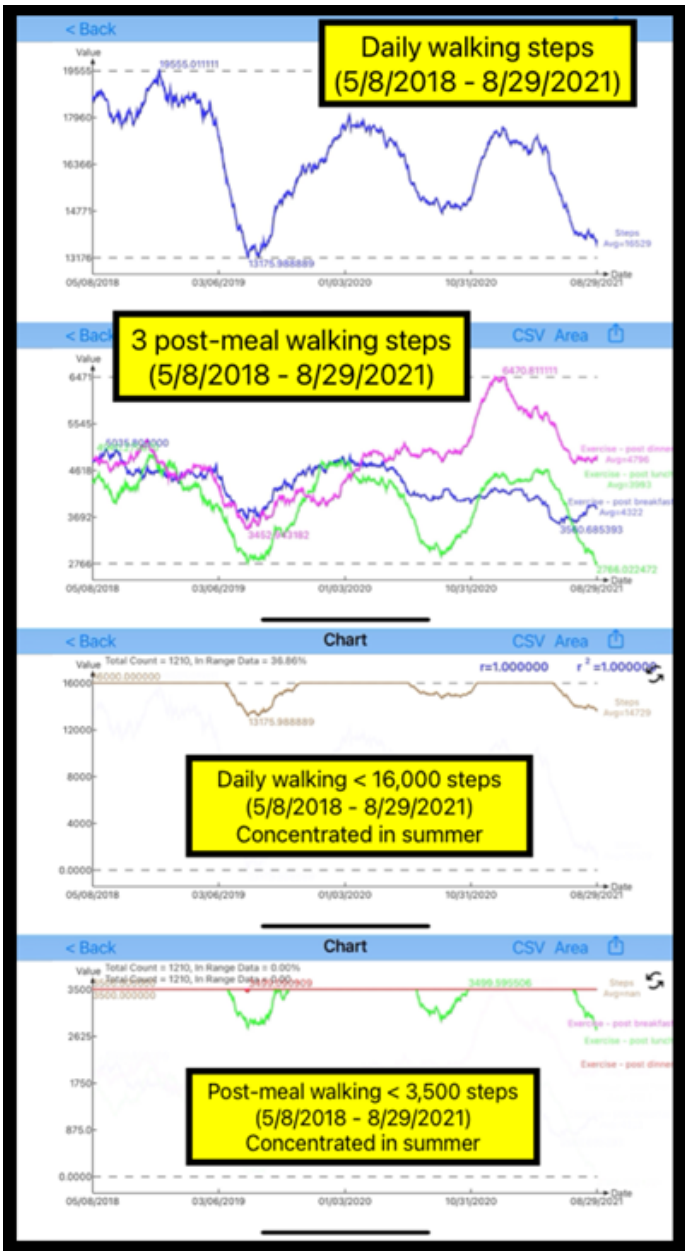

Figure 2: Segmentation analysis of daily walking steps <16,000 and post-meal walking steps <3,500 for a period from 5/8/2018 to 8/29/2021

Figure 3 illustrates PPG segmentation analysis (>130 mg/dL) with lifestyle pattern analysis of heavy travel during the period of 2018-2019. The middle diagram displays his daily PPG above 140 mg/dL, whereas the lower diagram exhibits the 90-days moving average PPG above 130 mg/dL. Both "graphical lumps" or high PPG values are concentrated within his heavy traveling period from 5/8/2018 to 1/15/2020. As a result, this proves that ***the higher PPG values are truly associated with his unhealthy lifestyles during his traveling years***

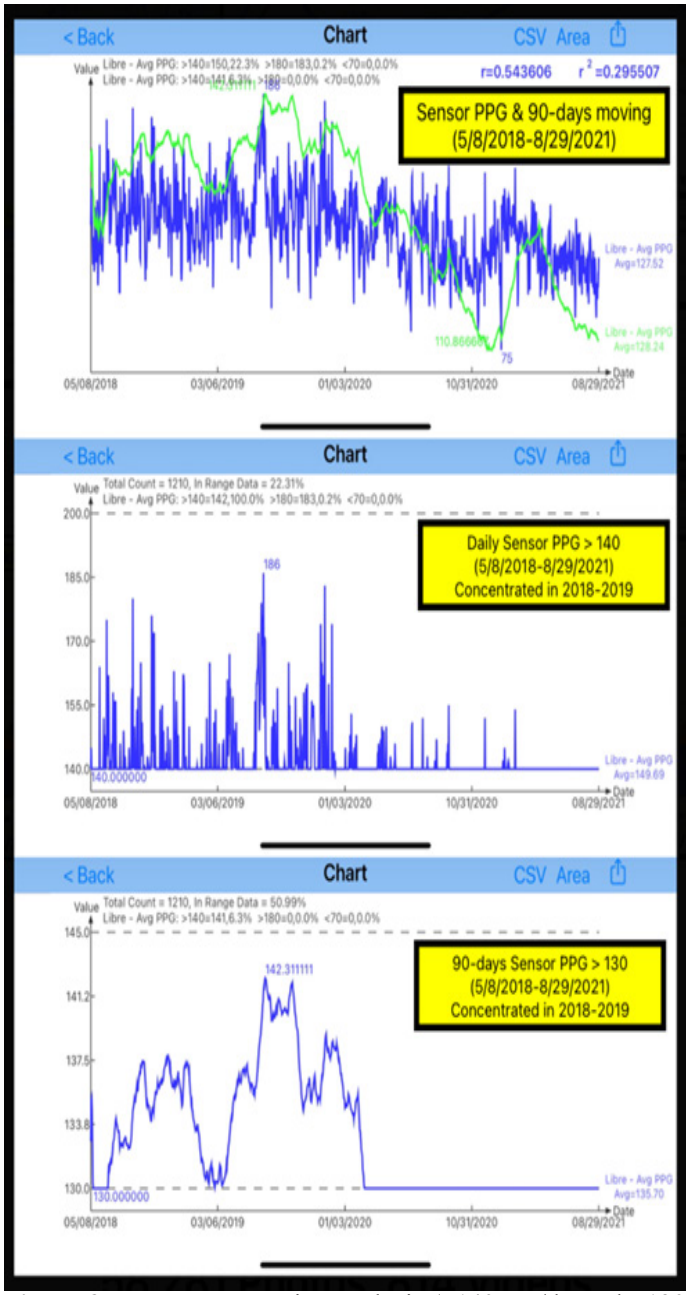

Figure 3: PPG segmentation analysis (>140 mg/dL and >130 mg/dL) with lifestyle pattern analysis of heavy traveling during 2018-2019

Conclusions

In summary, the summer's hot ambient temperature has caused him to unwillingly walk outside under the sun. This physical

reaction and psychological feeling have decreased his overall daily walking steps and post-lunch walking steps by around 3% to 5%. In theory, this rather small reduction on exercise could increase his PPG level upward a little; however, in reality, the overall lifestyle would exponentially affect his PPG level. During the period of 2018-2019, the author traveled through 50 international and US domestic cities, attended 65+ medical conferences, and made 120+ oral presentations. Under this kind of lifestyle pressure involving heavy business travel, such as catching airline flights, eating in restaurants, unable to avoid processed foods, finding suitable environment for walking, disturbing sleep schedules by jet-leg, and stress from different meeting events, would severely interrupt his normal regular life routines and then damage his health. Therefore, the results from his lifestyle pattern analysis and PPG segmentation analysis have shown two "graphical lumps" which are beyond 130 mg/dL in 90-days moving average case and beyond 140 mg/dL in daily PPG data case during the period of 5/8/2018 to 1/15/2010. Another interesting contrast is that his PPG levels are much lower and below 130 mg/dL level during the "COVID-19 self-quarantine" period from 1/19/2020 to 8/29/2021. Observation from this case study demonstrates that overall lifestyle, particularly food quality, has impacted glucoses more than the exercise factor alone. The above findings have also confirmed the statements of the 8 metabolic disorder's intra-cellular pathological pathways by Dr. Lustig (see Method section and Reference 1).

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.

1. Lustig, Robert H. MD, "Metabolical", HarperWave, HarperCollins Publisher, New York, 2021