ISSN: 2640-4133

Research Article

Advances in Bioengineering & Biomedical Science Research

A Three-Way Correlation Study for Body Temperature, Glucose and Blood Pressure Using the Collected Biomarker Data of 245 Days Based on GH-Method: Math-Physical Medicine (No. 461)

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Submitted: 11 Sep 2021; **Accepted:** 15 Sep 2021; **Published:** 25 Sep 2021

Citation: *Gerald C Hsu (2021) A Three-Way Correlation Study for Body Temperature, Glucose and Blood Pressure Using the Collected Biomarker Data of 245 Days Based on GH-Method: Math-Physical Medicine (No. 461). Adv Bioeng Biomed Sci Res 4(3): 26-29.*

Abstract

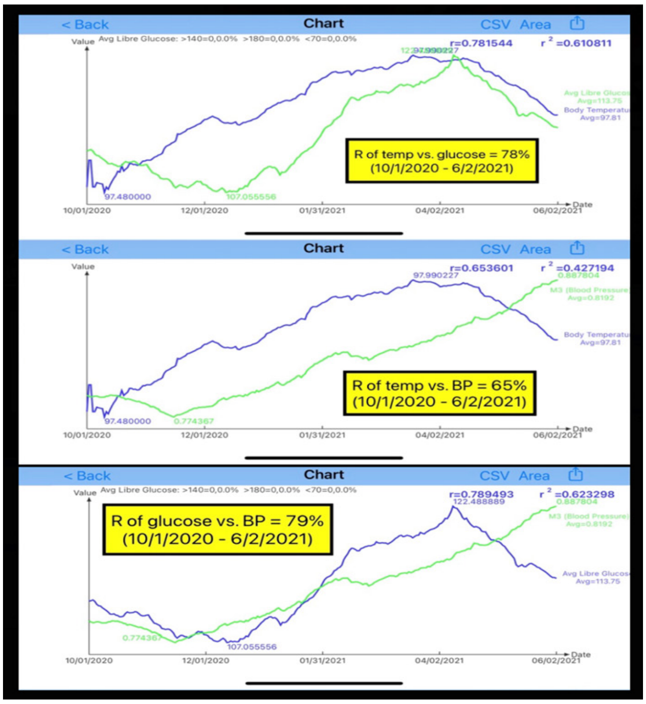
The author conducted multiple studies regarding the influences of ambient temperatures on his glucoses, including cold weather's negative influences on fasting plasma glucose (FPG) and hot weather's positive influences on postprandial plasma glucose (PPG). As a result, he incorporated ambient temperature or weather temperature as one of the ~20 influential factors of glucose formation in his AI-based glucose prediction model.

In his presentation at one of the European medical conferences in 2018, one medical doctor in the audience inquired whether his research work was conducted regarding the inter-relationship between body temperature and glucose. Not until 10/1/2020 did the author start to measure his body temperature on a daily basis. As of 6/2/2021, he collected a sufficient amount of his own body temperature data for a period of 8+ months or precisely 245 days.

This report covers the triple inter-relationship existing between body temperature versus glucose, body temperature versus blood pressure (BP), and glucose versus BP using simple statistical correlation coefficient calculations.

The correlation between sensor glucose and BP is the highest (79% for 8-months period and 85% for 3-years period), the correlation between body temperature and sensor glucose is in the middle, but similar to the results of sensor glucose versus BP (78% for 8-months period), and the correlation between body temperature and BP is the lowest (65% for 8-months period). Nonetheless, all three correlation coefficients are strong (>50%).

In summary, the body temperature is strongly related to both glucose and BP, where specifically, glucose and BP are extremely close-related to each other. These findings offer a clear indication of the existence of tight inter-relationships among the human body's numerous biomarkers and multiple organs.



Introduction

The author conducted multiple studies regarding the influences of ambient temperatures on his glucoses, including cold weather's negative influences on fasting plasma glucose (FPG) and hot weather's positive influences on postprandial plasma glucose (PPG). As a result, he incorporated ambient temperature or weather temperature as one of the ~20 influential factors of glucose formation in his AI-based glucose prediction model.

In his presentation at one of the European medical conferences in 2018, one medical doctor in the audience inquired whether his research work was conducted regarding the inter-relationship between body temperature and glucose. Not until 10/1/2020 did the author start to measure his body temperature on a daily basis. As of 6/2/2021, he collected a sufficient amount of his own body temperature data for a period of 8+ months or precisely 245 days.

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Method

Since 1/1/2012, the author has been collecting his finger-piercing glucose readings 4x a day (1 for FPG and 3 for PPG). In addition, starting from 5/5/2018, he has been utilizing a continuous glucose monitoring (CGM) sensor device where he accumulates 96 glucose values per day. The glucose data from the CGM sensor is used for this analysis.

He started to collect his blood pressure (BP) data on 2/3/2014. His BP readings contain three major components, systolic blood pressure or SBP (using 120 mm HG as its baseline), diastolic blood pressure or DBP (using 80 mm HG as its baseline), and heart rate or HR (using 60 bpm as its baseline). He then calculates a normalized metabolism index M3 which is related to BP using the following formula:

$$M3 = ((SBP/120)+(DBP/80)+(HR/60))/3$$

Where M3<1.0 means healthy and M3>1.0 means unhealthy.
Only until 10/1/2020, he begins recording his body temperature data early in the morning on a daily basis.

For data consistency, this study only compares body temperature, CGM sensor glucose, and his BP (M3) data during the specific period of 254 days from 10/1/2020 to 6/2/2021.

Ben Bikman, PhD, describes how glucose levels impact body temperature and how glucose spikes can lead to elevated temperature, which can impact sleep. Here is an excerpt from Reference 8:

"Bodies work to regulate countless processes. Paramount among these is body temperature. Even a body temperature shift of a few degrees can be catastrophic for our health; enzymes slow down, electrolytes get too low, and hormones don't work as well [1]. Unfortunately, temperature regulation in the body is disrupted when metabolic function is disrupted and glucose levels are elevated.

The heat we produce in our bodies is the result of countless chemical reactions occurring in every cell. This heat production is generally matched with an equal heat dissipation, ensuring body temperature stays in a narrow range. Human bodies have a unique advantage over other terrestrial mammals—our naked skin is a superior thermo-regulator, allowing us greater heat dissipation than other animals. Interestingly, glucose, a seemingly innocent nutrient, gets in the way.

Of course, the most obvious instance is elevated glucose is diabetes, where we see this phenomenon quite readily. Whether it's type 1 or type 2, people with diabetes have a harder time keeping body temperature in control [2]. This phenomenon is particularly evident with exercise in diabetes. During exercise, the increased physical exertion results in greater heat production, which is generally accounted for by a comparable increase in heat loss. However, the "heat loss" side of the equation is compromised with diabetes. Indeed, during a bout of exercise, someone with diabetes will keep up to 54% more heat than a comparably sized person without diabetes [2, 3]!

Importantly, the problem of glucose-induced changes in body temperature isn't simply a consequence of chronically elevated glucose levels. Even in healthy people without diabetes, acute spikes in glucose, either by glucose infusion or excessive carbohydrate consumption, body temperature climbs [4, 5].

The blood vessel is at the core of the problem with poor body temperature control and high glucose levels. To effectively remove heat from the body, we need a hemodynamic shift that arises from coordinated changes in the size of blood vessels throughout the body—blood vessels in the core of the body constrict, and those at the periphery (i.e., skin) dilate. These changes allow the body to transfer the heat from deep within the body to the skin and eventually to the air around the body.

Beyond the discomfort of being hot and sweaty, having a high body temperature can compromise optimal function, including one of the most important things we do for our health: sleep. Increased body temperature, especially through reduced heat dissipation, is one of the most common causes of "frequent waking" insomnia [6]. Thus, it's little surprise that consuming a high-carbohydrate load before bed, and the commensurate blood glucose and body temperature spike, results in more frequent waking and worse sleep [7].

So, if you're "feeling the heat," it might be time to check your glucose levels."

This article is well-written and informative. Its viewpoints are clearly stated via numerous "qualitative descriptions" based on a bio-chemical approach. However, it lacks mathematical proof and does not provide sufficient data to support its excellent viewpoints. As a result, the author adopts his developed math-physical medicine approach to conduct medical research work.

Results

Figure 1 displays the original input data of blood pressure (SBP, DBP, and HR), glucose values (finger glucose and CGM sensor glucose), and body temperature.

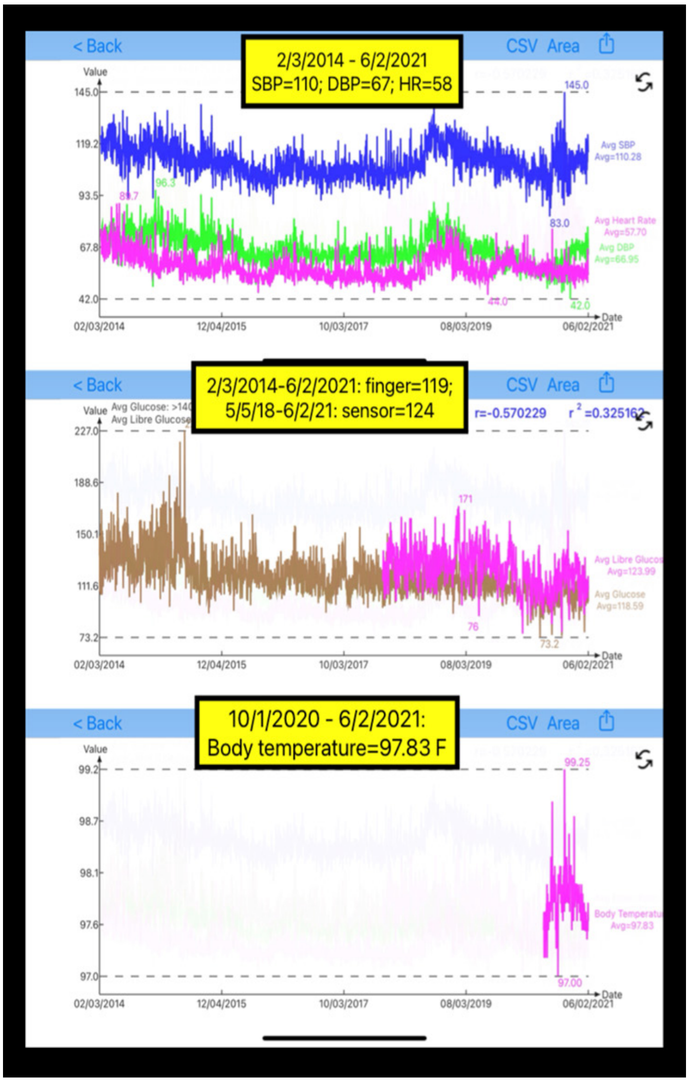

Figure 1: Collected data of BP, Glucose, and Body Temperature

Figure 2 illustrates a detailed daily body temperature chart which contains 4 extraordinary high-spikes of his body temperatures. A sudden spike disturbance usually means the human body has encountered some sort of extraordinary conditions which can distort a stabilized and smooth statistical curve diagram. Through a detailed examination of his body temperature chart, he has identified the sources of these 4 spikes. He had 2 shingle vaccine injections in November 2020 and January 2021 along with 2 COVID-19 vaccines in March 2021. These 4 vaccines produced "low fevers" on the 4 following days after the vaccinations.

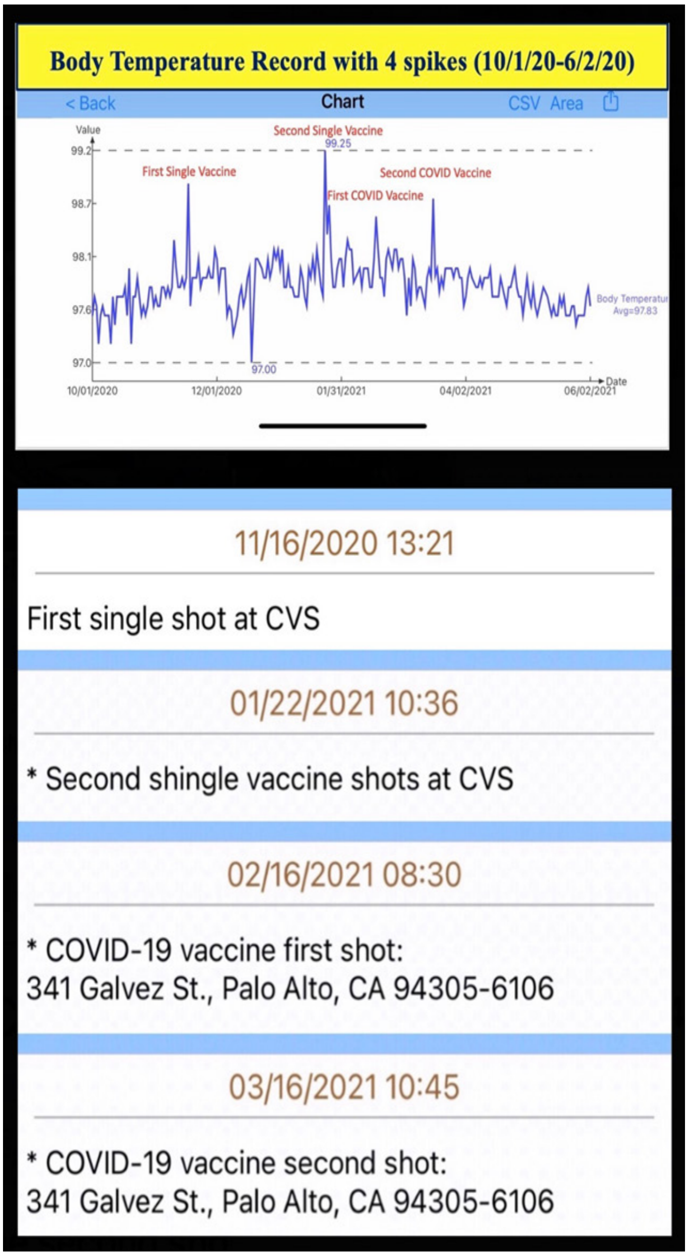

Figure 2: Daily Body Temperature (10/1/2020 - 6/2/2021) with 4 spikes

Other than the 4 isolated spikes, ***his body temperature has been maintained within a healthy range, between 97.0°F*** to 98.0°F, with an average body temperature of 97.83°F. This body temperature diagram also supports a finding that he has not been afflicted by the infectious COVID-19 virus.

Figure 3 demonstrates the correlations of body temperature versus glucose as 78% and the correlations of body temperature versus BP M3 as 65%. All three curves are trending upward starting from 10/1/2020 and reaching to their peaks approximately from 4/1/2021 to 6/2/2021.

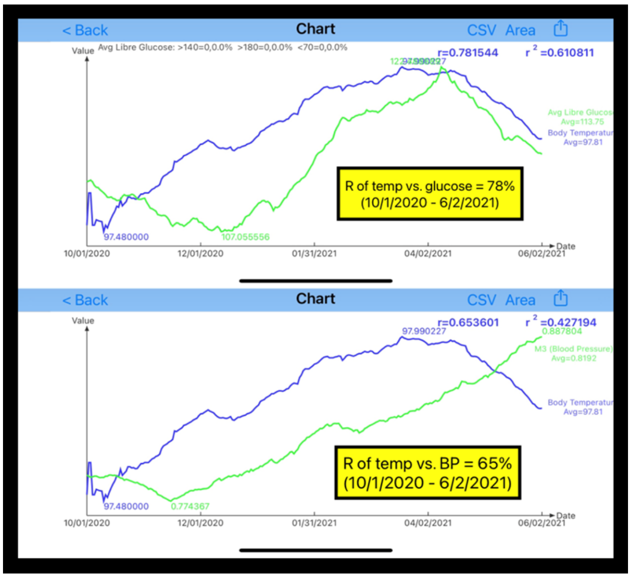

Figure 3: 78% of Body Temperature vs. glucose and 65% of body temperature vs. BP (M3)

Figure 4 reflects 2 diagrams of correlations between glucose and BP M3. The upper diagram depicts a shorter period of 8-months and the lower diagram shows the longer period of 3-years. The correlation for the shorter period is 79%, while the longer period is 85%. As we can see, the longer period contains more data that reveal deeper meaning and true reality; therefore, ***glucose does have a tight and strong inter-relationship with BP.***

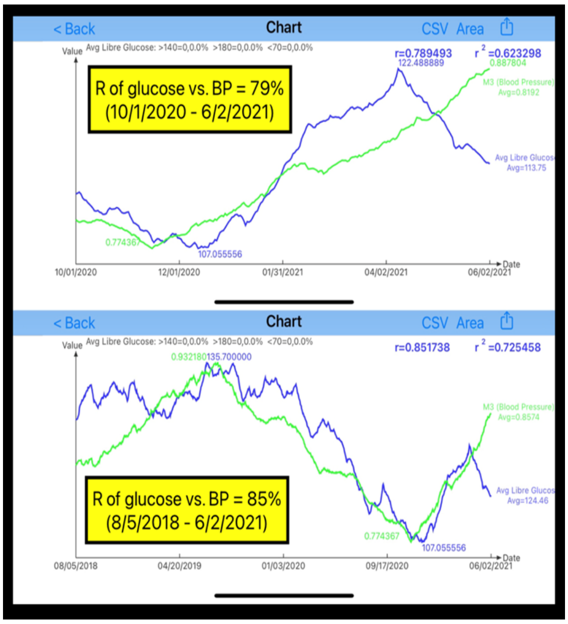

Figure 4: Glucose vs. BP (M3) for both 8-month shorter period (79%) and 3-year longer period 85%)

Conclusions

*The correlation between sensor glucose and BP is the highest (**79%** for 8-months period and **85%** for 3-years period), the correlation between body temperature and sensor glucose is in the middle, but similar to the results of sensor glucose versus BP (**78%** for 8-months period), and the correlation between body temperature and BP is the lowest (**65%** for 8-months period). Nonetheless, all three correlation coefficients are strong (>50%).*

In summary, the body temperature is strongly related to both glucose and BP, where specifically, glucose and BP are extremely close-related to each other. These findings offer a clear indication of the existence of tight inter-relationships among the human body's numerous biomarkers and multiple organs.

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