Atherosclerosis: Open Access

Hsu, Atheroscler open access 2020, 5:2

Short Communication Open Acces

A Simple Formula Based on Postprandial Plasma Glucose Prediction using 5,640 Meals Data *via* GH-Method: Math-Physical Medicine (No. 301)

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Abstract

This article is based on the continuation of the author's research work, a simple and practical, yet highly accurate postprandial plasma glucose (PPG) prediction formula for Type 2 Diabetes (T2D) patients. His methodology is the developed GH-Method: Math-Physical Medicine (MPM) which has been utilized repeatedly in the past decade.

The predicted PPG formula-based on the status of fasting plasma glucose (FPG), carbs/sugar intake amount, and post-meal walking steps are as follows:

Predicted PPG=0.97*FPG+(carbs/sugar grams*1.8)-(post-meal walking steps in thousand*5)

The conclusive results have the order of values m1/m2/m3/prediction accuracy %.

Case A:1.8/5.0/0.97/99.8%

Case B:2.0/5.0/0.945/99.9%

Case C:2.2/5.0/0.92/99.9%

Exercise is important, contributing ~3% higher than food, is easily achieved compared to the required knowledge of diet. As a result, the author spent four years to study food nutrition. Most T2D patients are seniors; therefore, he suggests that walking is the best form of exercise. However, the most difficult part of exercise is the behavior psychology related to the issue of "discipline and persistence". T2D patients need to walk between 2,000 to 4,000 steps after each meal. The author walks an average of 4,300 steps after each meal. On the other hand, diet (carbs/sugar amount and nutritional balance) requires much more and deeper knowledge of food nutrition in order to control diabetes. Therefore, the author developed an AI-based tool to assist T2D patients.

For non-tech patients, the following simple guidelines can assist with meal intake:

Starchy food:

Eat an amount half of your fist or hand at most.

Colorful vegetables:

Eat an amount limited to one fist or hand.

Green vegetables:

Eat an amount limited to 2.5 fists or hands.

Please note: you must combine two types of vegetable together in order to get the total intake limitation.

The author highly recommends the patients to measure their FPG at least several times a quarter, in order to get a quarterly average FPG value. The other three PPG values can then utilize the formula-based predicted PPG to control their overall diabetes conditions.

The described method mentioned above in regard to the predicted PPG formula along with the post-meal walking exercise and carbs/sugar intake amount can help patients control their diabetes without painful and troublesome finger-piercing glucose measurements. The author has been measuring his glucoses for 8.5 years (3,126 days) with finger-piercing glucose testing combined with his 10-years of diabetes research work. He hopes this article can provide useful guidelines to other diabetes patients to take back their lives from this dreadful chronic disease.

Keywords: Postprandial Plasma Glucose (PPG); Type 2 diabetes; Fasting Plasma Glucose (FPG); Hypertension; Cardiovascular diseases

Introduction

This article is based on the continuation of the author's research work, a simple and practical, yet highly accurate postprandial plasma glucose (PPG) prediction formula for type 2 diabetes (T2D) patients [1,2]. His methodology is the developed GH-Method: math-physical medicine (MPM) which has been utilized repeatedly in the past decade.

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Received September 07, 2020; **Accepted** September 28, 2020; **Published** October 05, 2020

Citation: Hsu GC (2020) A Simple Formula Based on Postprandial Plasma Glucose Prediction using 5,640 Meals Data *via* GH-Method: Math-Physical Medicine (No. 301). Atheroscler Open Access 5: 135.

Methods

GH-method: Math-Physical Medicine (MPM) methodology

The description below explains the MPM research methodology developed by the author utilized in his biomedical research.

Any system whether political, economic, engineering, biological, chemical, and even psychological have causes or triggers (inputs) and consequences (outputs). There are definitely some existing connections between inputs and outputs that can be either simple or complicated. The inputs and outputs of any type of system, whether psychological, biological, chemical or medical, can be observed visually or measured by certain instruments. These physically observed phenomena, including features, images, incidents, or numbers are merely the partial "physical expression" of these underneath system structure. This system structure includes human organs for a biomedical system, the human brain for a neurological or mental system, or steel plate for structural or mechanical engineering system.

Once we have collected these readings of the physical phenomena (external expression, similar to a behavior, symptom, or response), through either incident, image, or data, we should be able to organize or categorize them in a logical manner. When we check or analyze these partial physical phenomena outputs and cannot figure out why they act or behave in certain way (internal causes, reasons, or stressors), we can try to develop some guesses or formulate some hypotheses based on basic principles, theories, or concepts from physics. At this point, we just cannot pull out an equation from a physics textbook and insert these input variables in to conduct a "plug and play" game. An equation is an expression of a concept or a theory, which is usually associated with some existing conditions, either initial or boundary; however, a biomedical system usually has different kind of conditions from other systems.

After understanding the meaning of observed physical phenomena, the next step is to prove the hypothesis, guess, or interpretation of the phenomenon being correct or incorrect. At this stage, a solid understanding of mathematics becomes extremely useful to develop a meaningful model which could represent these observed physical phenomena and created hypothesis. In addition, some engineering modeling techniques, such as finite element method and computer science tools, including software, artificial intelligence (AI), and/or big data analytics can offer great assistance on verification of analysis results from these mathematical operations. If the mathematical results cannot support the created hypothesis, then a new hypothesis needs to be formulated.

When this new hypothesis is proven to be correct, then we can extend or convert this hypothesis into a useful mathematical equation or into a simpler formula for others to adopt this easier way of thinking and understanding of the results. In the final stage, the derived mathematical equation or arithmetical formula can then be used to "predict" future outcomes of the selected system based on all different sets of inputs.

The author has spent the past 10 years to self-study and research metabolism, endocrinology, and diabetes. This article describes his developed simple formula-based PPG prediction using the above described MPM approach. For example, his predicted PPG formula-based on status of FPG, carbs/sugar intake amount, and post-meal walking steps are listed as follows:

Predicted PPG=0.97*FPG+(carbs/sugar grams*1.8)-(post-meal walking steps in thousand*5)

It was not an easy task for the author to discover these three numbers, 0.97, 1.8, and 5.The simple PPG prediction formula was developed from his 3-years of intensive research work based on his ~500,000 collected data. Though this formula expression is simple, yet its calculated results are highly accurate with a 99.8% of prediction accuracy. The most important factor is that this simple formula can assist a T2D patient to control the glucoses effectively [3].

Glucose

The author spent 4 years, from 2010 to 2013 to self-study 6 chronic diseases, obesity, diabetes, hypertension, hyperlipidemia, cardiovascular diseases, stroke, as well as food nutrition. Food is probably the most significant and complicated input element of these six chronic diseases. After his 4 years of self-reading and learning, he then spent the entire year of 2014 to develop a complicated model of metabolism. This mathematical model contains 4 biomarkers of medical conditions including weight, glucose, blood pressure, and lipids, along with 6 lifestyle details such as food portion and nutritional balance, water intake, exercise, sleep amount and quality, stress reduction, and daily life routines regularity.

Starting from 2015, he spent three consecutive years to discover the characteristics and behaviors of this complex "wild beast" of glucose. His major objective is to truly understand the "inner characteristics" of glucose, not just using medications to control its "external symptoms". His research work is similar to a horseman trying to tame a horse by understanding its temperament first, not just giving a tranquilizer to calm it down. As a result, over this period of 3 years (2015-2017), he has developed 4 prediction models, which include Weight, PPG, FPG, and HbA1C for the purpose of understanding glucoses.

The author estimated and proved that PPG contributes approximately 75% to 80% towards HbA1C. Therefore, he tried to unravel the mystery of PPG first. Through his diabetes research, he has identified at least 19 influential factors associated with PPG formation. Among those influential factors, diet (carbs/sugar amount) would provide ~38% and exercise (he choose walking) would contribute ~41%. In summary, these two primary influential factors add ~80% of the PPG formation. Among the rest of 17 secondary factors, the weather temperature contributes ~5%, stress and illness only make noticeable contributions when they occur. Since he used the "annual" data for this research project, the average weather temperature patterns associated with both hot summer and cold winter would be similar from year to year. Therefore, he omit the weather temperature factor in building the equation.

For most T2D patients who take medications, its biochemical effect would become the most substantial influential factor. However, as we know, medication cannot cure diabetes and only control its symptoms. Therefore, the author decided to focus on diabetes control at the most fundamental level by resolving the root cause. Previously, he has taken high doses of three prescribed diabetes medications for 18 years since 1997; however, in 2013, he reduced the number of prescriptions and dosages of his daily medications. By 12/8/2015, he finally ceased taking any diabetes medications. Though the data he used for this particular research, including a nominal influence of taking 250 mg of Metformin in 2015, the total contribution from this small medication input on his results is less than 1%.

Two scientific discoveries were identified by using his previous big data analytics and trial-and-error method from the collected biomedical data. First, one gram of carbs/sugar amount would convert into 1.8 to 2.2 mg/dL of additional PPG, depending on many varieties of food factors. Second, every one-thousand post-meal walking steps would decrease 5

mg/dL of his PPG level, in a near constant conversion rate. His post-meal walking steps have been maintained at a rate of approximately 4,300 steps per meal. Since his exercise is a constant, he conducted a variance study of three conversion rates from each carbs/sugar gram to PPG mg/dL level that is 1.8, 2.0, and 2.2 mg/dL per gram.

From 2016 to 2017, he discovered a solid connection between his FPG and his weight (>90% of correlation). In addition, similar to his PPG research, he also recognized that there are about 5 influential factors of FPG formation with weight alone contributing ~85% and cold weather temperature influencing ~5%.

Since July 2019, he launched his investigation on the degree of damage to his pancreatic beta cells. During this one-year of research task, he noticed that his FPG has been decreased in the past 6 to 8 years at an annual rate of 2.3% to 3.2%. In other words, his pancreatic beta cells have been self-regenerating approximately 14% to 26% for these past years. He then thought about FPG as being a good indicator on how healthy his pancreatic beta cells are since there are no food intake and exercise while sleeping. It makes sense that FPG carries a significant and clear message about the baseline status of his overall glucoses. This is how he decided to use FPG to convert into his "baseline PPG".

In early 2015, he further utilized 8 influential factors with AI and optical physics technologies to develop an AI-based Glucometer APP to predict PPG [4]. This APP can automatically guesstimate the carbs/sugar amount from the meal photos he took, where each photo contained 160 million digits of information. The AI predicted PPG values have reached to a 99.9% prediction accuracy based on his measured PPG values from his 5,640 meals data (Figure 1).

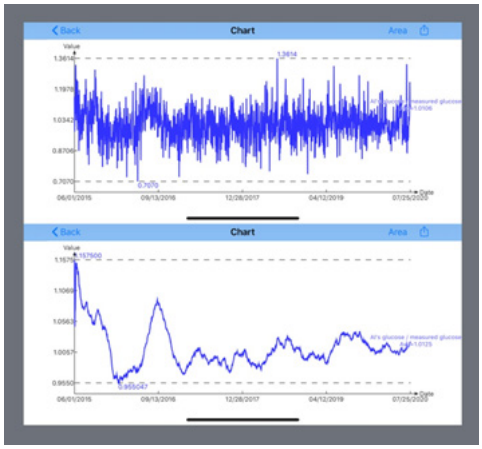

Figure 1: AI predicted PPG versus finger-piercing measured PPG (prediction accuracy at 99.9%).

Results

The author then utilized his acquired diabetes knowledge and his own collected big data of 5,640 meals in 1,880 days to identify the best-estimated values for baseline PPG from FPG times multiplier 3 (m3), Carbs/sugar amount times multiplier 1 (m1), and Post-meal walking steps times multiplier 2 (m2). He further verified the validity of the equation by calculating their linear accuracies (must be greater than 95%) between measured PPG data versus both AI-based PPG and Formula-based PPG predictions.

Next, he describes his developed formula-based linear equation to simulate the complex PPG phenomena as follow:

Formula of predicted PPG=(FPG*m3)+(Carbs/Sugar grams*m1)-(Walking Steps in 1,000*m2)

Where FPG times m3 is the baseline PPG which indicates his recent stabilized health state of pancreatic beta cells. The three variables, m1, m2, and m3, are three conversion multipliers. The m2 value is fixed at 5.0, where m1 values are using three values of 1.8, 2.0, and 2.2, which will then obtain three calculated m3 values that are equal to 0.97, 0.945, 0.92 respectively, to keep the formula's PPG prediction accuracy above 99.8% (Figure 2).

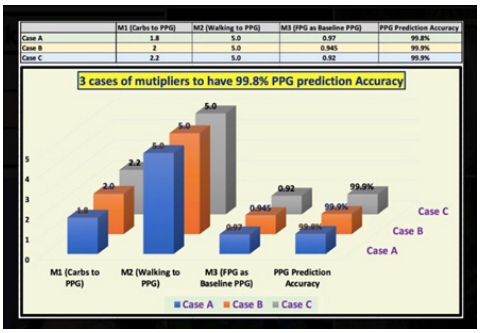

Figure 2: Summarized three multipliers (m1, m2, m3) and formula-based PPG prediction accuracy% (99.8% to 99.9%).

Based on the above description, there are three different calculation data tables with three-line curves of measured PPG, AI-based predicted PPG, and formula-based predicted PPG (Figures 3-5).

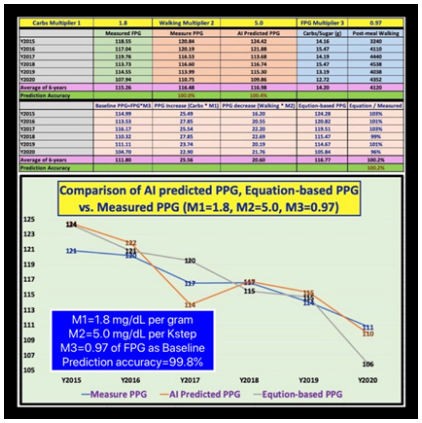

Figure 3: Summarized data table and line chart for m1=1.8 and m3=0.97 with accuracy of 99.8%.

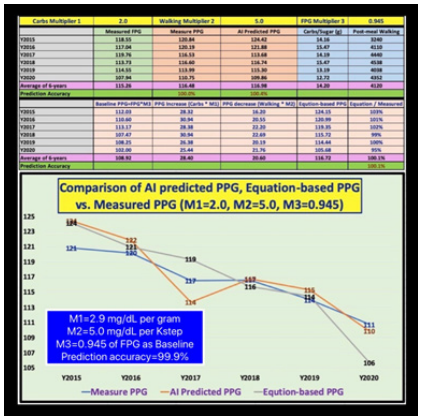

Figure 4: Summarized data table and line chart for m1=2.0 and m3=0.945 with accuracy of 99.9%.

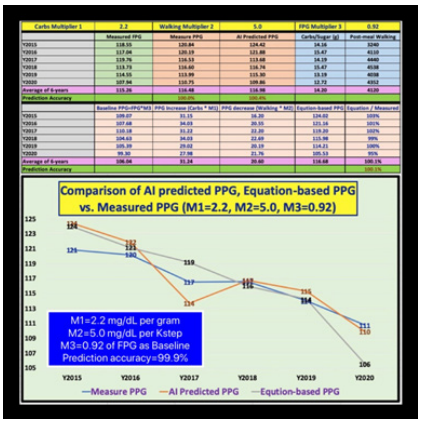

Figure 5: Summarized data table and line chart for m1=2.2 and m3=0.92 with accuracy of 99.9%.

The following list summarizes these three figures with the conclusive results in the order of values m1/m2/m3/prediction accuracy%:

Case A:1.8/5.0/0.97/99.8%

Case B:2.0/5.0/0.945/99.9%

Case C:2.2/5.0/0.92/99.9%

Conclusion

The predicted postprandial plasma glucose, PPG formula-based on the status of fasting plasma glucose (FPG), carbs/sugar intake amount, and post-meal walking steps are as follows:

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