Using GH-Method: math-physical medicine approach and various glucose data to investigate the health state of a type 2 diabetes patient's pancreatic β- cells

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Research Article

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Introduction

This paper describes an application of GH-method MPM approach to investigate the author's pancreatic β-cells health state using both PPG and FPG data obtained via both sensor collected and finger-piercing methods.

Methods

The glucose collection period is 699 days (from 5/5/2018 through 4/4/2020). He has collected 52,823 sensor glucose data (~76 times per day) and 2,796 finger glucose data (four times per day). Furthermore, he has also collected his carbs/sugar intake amount and post-meal walking steps for each meal during this period.

He divided this entire period into eight quarters (except the 8th quarter has only 63 days) and then calculated average glucoses, average carbs/sugar intake, and average walking steps for each quarter. These results are shown in Figures 1 (PPG) and 2 (FPG).

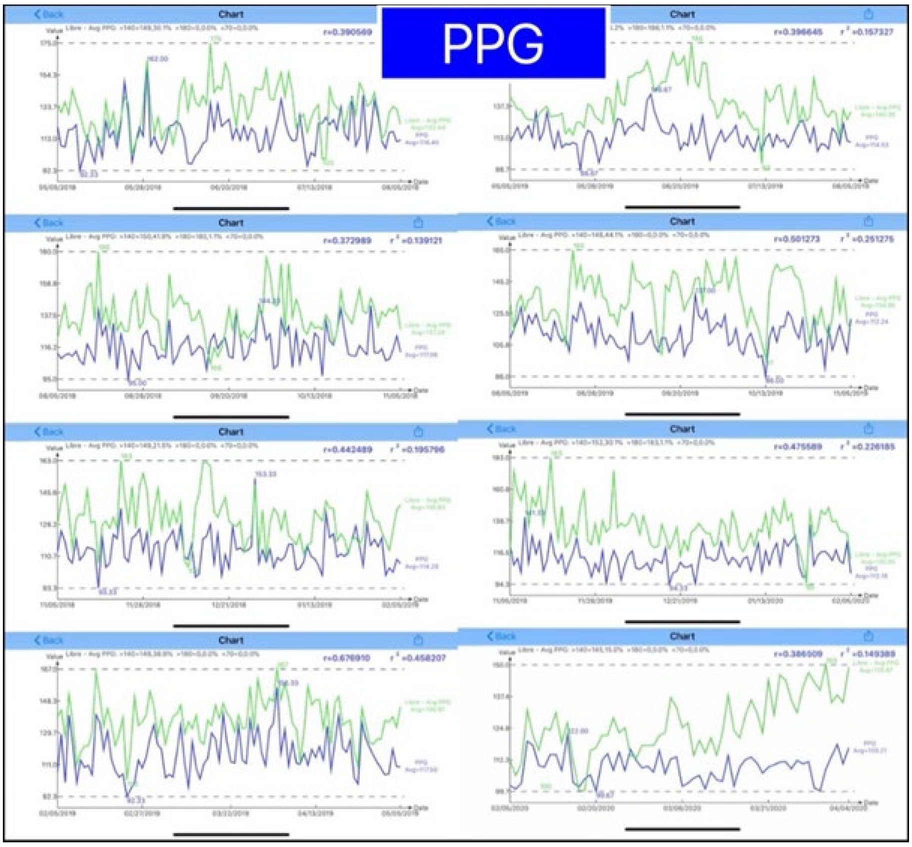


Figure 1: 8-quarters PPG (both Sensor and finger)

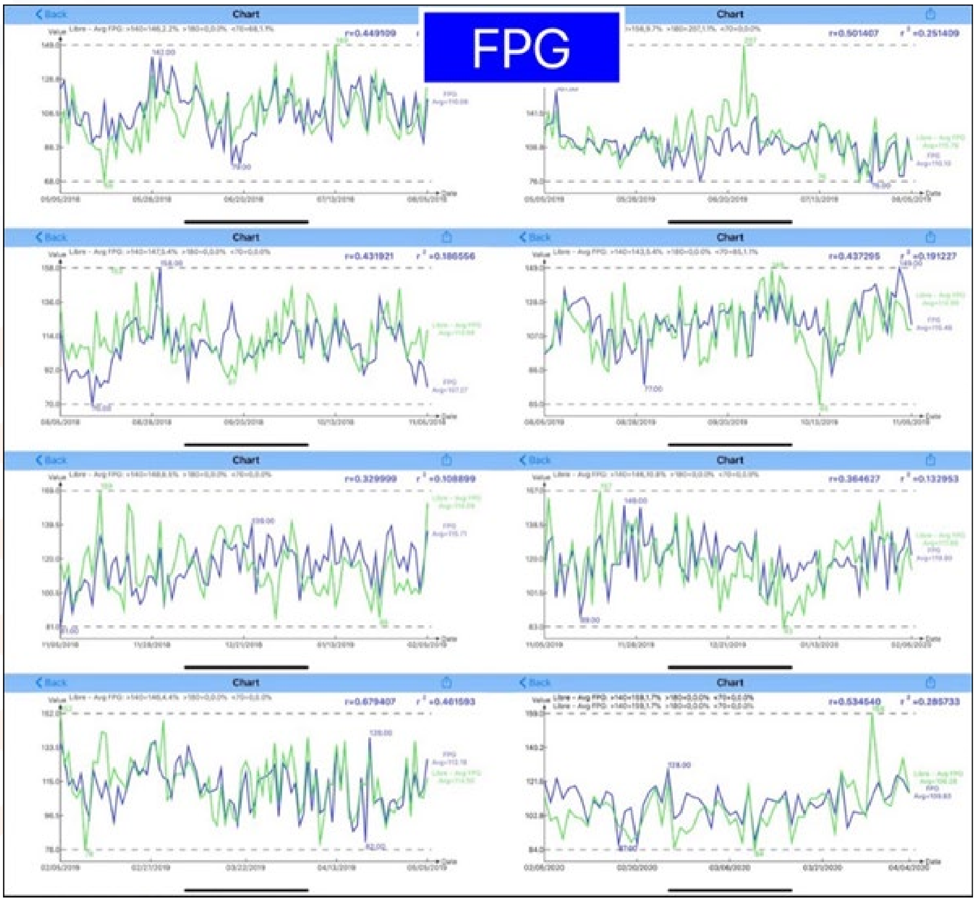


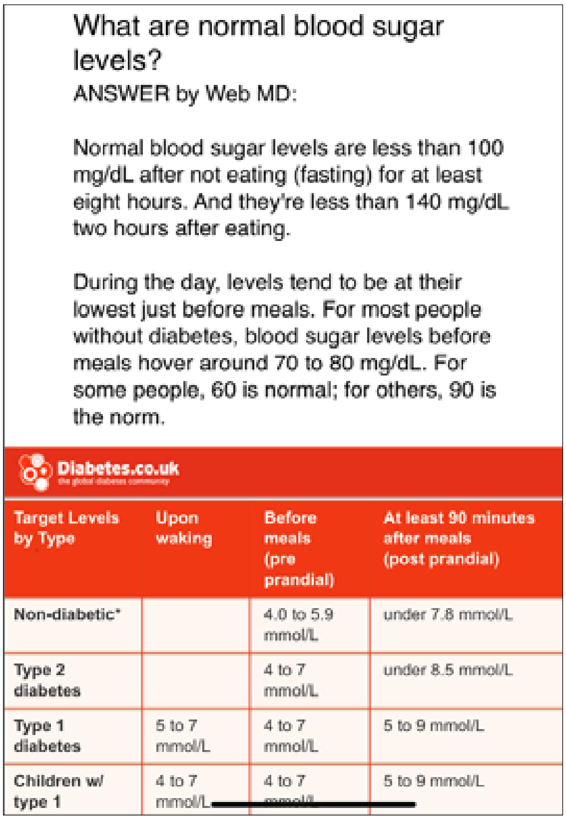
Figure 2: 8-quarters FPG (both Sensor and finger)

As described in his previous paper (see his research notes 94 and 99), he developed the following linear glucose prediction equation:

PPG = A + (f(x) * B - f(y) * C) * D
Where
f(x) = carbs/sugar intake in grams
f(y) = walking steps in thousands
Variable A = baseline glucose value which indicates patient's combined health state of pancreas and liver.
Variables B, C, & D = 3 different multipliers which were obtained through his big data analytics in the past.

As indicates in his previous research note 242 (PPG), he calculated his baseline PPG by removing the influences from both carbs/sugar intake, f(x), and post-meal walking steps, f(y). And then, he compared his baseline PPG against a normal person's (non-diabetes) PPG value (89 mg/dL) in order to guesstimate his own pancreatic β-cells health state.

For the FPG case, since it has no influences from both food and exercise, he directly compared his average quarterly FPG against a non-diabetes patient's normal FPG value (89 mg/dL).


What are normal blood sugar levels?
ANSWER by Web MD:

Normal blood sugar levels are less than 100 mg/dL after not eating (fasting) for at least eight hours. And they're less than 140 mg/dL two hours after eating.

During the day, levels tend to be at their lowest just before meals. For most people without diabetes, blood sugar levels before meals hover around 70 to 80 mg/dL. For some people, 60 is normal; for others, 90 is the norm.

Diabetes.co.uk
the global diabetes community

Target Levels by Type	Upon waking	Before meals (pre prandial)	At least 90 minutes after meals (post prandial)
Non-diabetic*		4.0 to 5.9 mmol/L	under 7.8 mmol/L
Type 2 diabetes		4 to 7 mmol/L	under 8.5 mmol/L
Type 1 diabetes	5 to 7 mmol/L	4 to 7 mmol/L	5 to 9 mmol/L
Children w/ type 1	4 to 7 mmol/L	4 to 7 mmol/L	5 to 9 mmol/L

Figure 3: Glucose ranges for normal people and T2D patients

Figure 3 (references: WebMD and diabetes.com.uk) shows the normal glucose range for a non-diabetes patient are within the range of 4.0 mmol/L to 5.9 mmol/L (about 72 mg/dL to 106 mg/dL). In order to simplify his calculations, the author has decided to use an average glucose value from this range, i.e. 4.95 mmol/L or 89 mg/dL, as a "normal" person's glucose value.

Results

Period of dates	5/18-8/18	8/18-11/18	11/18-2/19	2/19-5/19	5/19-8/19	8/19-11/19	11/19-2/20	2/20-4/20	5/18-4/20	
Quarter Number	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 5	Quarter 6	Quarter 7	Quarter 8	Average	Compare 89
S: Sensor PPG (mg/dL)	132	137	131	137	140	135	135	126	134	
F: Finger PPG (mg/dL)	116	117	114	118	115	112	112	109	114	
Sensor PPG / Finger PPG	114%	117%	114%	117%	123%	120%	120%	115%	118%	
Sensor FPG (mg/dL)	107.30	113.98	114.09	114.50	115.78	112.99	117.88	106.28	113	127%
Finger FPG (mg/dL)	110.08	107.27	115.71	112.18	110.10	115.46	119.80	109.80	113	126%
SensorFPG / Finger FPG	97%	106%	99%	102%	105%	98%	98%	97%	100%	
Quarter Number	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 5	Quarter 6	Quarter 7	Quarter 8	Average	
f(X): Carbs/Sugar (grams)	15	17	15	15	12	11	15	12	14	
f(Y): Post-meal Walking (Steps)	4468	4575	4340	3429	3906	4423	4513	4741	4299	
PPG Adjustment = f(X)*B-(f(Y)/1000)*C	10	14	11	16	7	2	9	3	9	
A: PPG Baseline = S/PPG - Adjustment	123	123	120	121	134	133	126	123	125	141%
Sensor Accuracy %	2%	2%	4%	3%	-6%	-6%	0%	1%	0%	
PPG Adjustment = f(X)*B-(f(Y)/1000)*C	10	14	11	16	7	2	9	3	9	
A: PPG Baseline = F/PPG - Adjustment	107	103	103	101	108	110	103	107	105	118%
Finger Accuracy %	-1%	2%	2%	3%	-2%	-4%	2%	-1%	0%	

Figure 4: Calculation Table of both quarterly averages and summarized data

Figure 4 shows his calculation results based on his collected PPG, FPG, carbs/sugar amount and post-meal walking steps. The followings are summarized conclusions:

1. **Measured PPG:** Sensor 134 mg/dL is 18% higher than Finger 114 mg/dL.
2. **Baseline PPG:** Sensor 125 mg/dL is 19% higher than Finger 105 mg/dL.
3. **Baseline PPG vs. Normal (89 mg/dL):** Sensor is 141% higher than normal; Finger is 118% higher than normal.
4. **Measured FPG:** Both Sensor and Finger are 113 mg/dL which is 127% higher than normal glucose (89 mg/dL).
5. Average carbs/sugar intake amount is 14 grams and average post-meal walking steps are 4,299. These two factors has a combined impact on PPG of +9 mg/dL (add this value on top of the baseline PPG).

Based on #3 and #4 of the summarized conclusions, the three highest "baseline glucose" values are: 141%, 118%, and 127%. The author's pancreatic β-cells remaining functional strength level can be calculated by this formula:

100% - (above % - 100%)

Therefore, the author's remaining functional strength levels of β-cells are: 59%, 82%, 73%, or within the range between 59 % to 82%. Alternatively, it can be expressed that his pancreatic β-cells have been damaged within the range of 18% to 41% during this 8-quarter period.

Conclusion

This big data analytics was conducted based on the collected 59,813 data which consist of 55,619 glucoses, 4,194 carbs/sugar amounts with post-meal walking steps. He then calculated those vital "baseline PPG" data for both Sensor and Finger. In combination with his measured FPG values (equal value for both Sensor and Finger) and the comparison against a normal person's "should-be" glucose level at 89 mg/dL, he could identify his pancreatic β-cells health state of the remaining functional strength within the range of 59% - 82%. Or, to express it in another way, his β-cells have been damaged within the range of 18% - 41%. It is important to point out another two important facts at here: the author maintained a stringent lifestyle management on both diet and exercise and he did not take any diabetes medication during this period of 699 days [1-5].

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