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An Investigation Into The Effect Of Blood Glucose Level Changes On LF/HF Parameter Of HRV Signal In Non-Diabetic And Diabetic Individuals

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AN INVESTIGATION INTO THE EFFECT OF BLOOD GLUCOSE LEVEL
CHANGES ON LF/HF PARAMETER OF HRV SIGNAL IN NON-DIABETIC
AND DIABETIC INDIVIDUALS

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Acting Dean of the Graduate School

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Reza Amanipour

2011

Dedication

I would like to dedicate this thesis to my mother Mahnoush Shafiei who throughout my academic career has given me all her love and encouragement and continue to cheer me on as I move forward to getting my Ph.D I hope to forever make her proud.

AN INVESTIGATION INTO THE EFFECT OF BLOOD GLUCOSE LEVEL
CHANGES ON LF/HF PARAMETER OF HRV SIGNAL IN NON-DIABETIC
AND DIABETIC INDIVIDUALS

by

REZA AMANIPOUR, B.S.

THESIS

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for the Degree of

MASTER OF SCIENCE

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Abstract

The analysis of time duration between consecutive R waves of electrocardiogram (ECG) is a standard method to evaluate the variations in heart rate. The physiological literature reveals that blood glucose levels modulate the autonomic nervous system (ANS) activity and heart rate variability (HRV) is representative of the cardiovascular autonomic function. In the research, an investigation was carried out to investigate the relationship between HRV signal measures derived from ECG and arterial blood glucose changes in five non-diabetic and five diabetic individuals during normoglycemic and mildly hyperglycemic conditions. A CleveLabs BioCapture wireless device was used to acquire ECG signals from ten subjects. The PhysioToolkit Software was used to extract the HRV signal and the Kubios software package was deployed to perform comprehensive HRV signal analysis. This software has an easy-to-use graphical user interface that displays the HRV signal and provides three options to calculate: Time-domain, Frequency-domain and Nonlinear Dynamics parameters from raw HRV signals. In its Frequency-domain analysis section, it provides frequency bands such as VLF (Hz), LF (Hz), and HF (Hz), with LF/HF as an index that reflects the sympathovagal balance of the ANS. ECG data were acquired for 30 minutes during normoglycemic mildly hyperglycemic conditions, while blood glucose levels were measured manually by the subject using a glucometer every 10 minutes. ECG signal segments of 5 minute durations were then processed to extract HRV signals and these in turn were analyzed to provide frequency-domain measures. The results indicated that blood glucose changes were inversely related to LF/HF. For this dataset, it was observed that the LF/HF decreased in non-diabetic and diabetic individuals when blood glucose levels increased.

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Chapter 1: Introduction

Diabetes affects nearly 26 million Americans representing nearly 8.3 percent of Americans of all ages (National Diabetes Fact Sheet for 2011). An estimated 27 percent of those with diabetes (7 million Americans) do not know they have the disease. In a study published last year, the CDC projected that as many as 1 in 3 adults in the United States could have diabetes by 2050 if current trends continue [1]. Diabetes is the seventh leading cause of death in the United States, and diabetes costs \$174 billion annually, including \$116 billion in direct medical expenses [1].

The U.S.-Mexico Border Diabetes project documented that in 2003 more than 1.11 million inhabitants of the U.S.-Mexico border region had diabetes. The goal of the U.S.-Mexico Border Diabetes Prevention and Control Project is to prevent diabetes complications by controlling diabetes among people who have type 2 diabetes in the U.S.-Mexico border region. This project indicated that overweight and obesity rates were high with prevalence values among diabetes in the Mexico border states at 27% and in the U.S. border states at 54.5% [2]. Data provided by the El Paso Diabetes Association (EPDA) shows that more than 85,000 persons in El Paso are affected by diabetes and as many as 25 percent of those have not been diagnosed. Type 2 diabetes affects 90 percent of all diabetics in El Paso [3].

Understanding how diabetes affects the body is important to effectively monitoring the disease. Sugar is an essential constituent of the blood. It is also called "blood glucose" [4]. In the morning before breakfast, the blood glucose concentration is between 80 and 90 mg. per 100 cc. of blood. It is essential to normal health that the blood glucose level be maintained within this range, and that it should not fall below this range for periods longer than an hour. After a meal

containing sugar, the blood glucose level is elevated, usually reaching a concentration of 120 to 140 mg. after 1.5 to 2 hours, and then gradually falling during the third and fourth hours to the previous fasting level. In some individuals the blood glucose level may reach 180 mg. and higher after a meal containing sugar, and, accompanying this high level, sugar may be found in the urine [4].

This abnormally high concentration of blood glucose is called hyperglycemia (excessive blood glucose). The opposite state, an abnormally low blood glucose concentration, is called hypoglycemia (low blood glucose). The blood glucose level in diabetics is constantly changing; therefore, they must continually monitor their blood glucose level. It is challenging to precisely monitor blood glucose levels due to sudden changes in blood glucose level, especially after having a meal containing a large amount of sugar.

Diabetes can lead to secondary complications such as hearing loss, blindness, neuropathy, poor circulation, heart disease, and kidney failure [5]. Some of these complications can make using commercially available glucose monitors a difficult process [6]. With type 1 diabetes it is more difficult to maintain a balance of insulin and blood glucose because the organ that secretes insulin is no longer functioning. Due to the absence of insulin production, people with type 1 diabetes must either inject or use an insulin pump to supply insulin to remove glucose from the blood and enable the body's cells to utilize glucose to provide energy. In people with type 2 diabetes, the organ that produces insulin is working, but either there is a shortage of insulin produced, or the body ignores the insulin and does not know how to properly use it to get the glucose into the cells.

Monitoring the range of blood glucose levels is essential to optimal management of diabese. Through close monitoring a diabetic person learns how food, activity levels, stress, medicine, and insulin affect their blood glucose level. This information will help individuals maintain their health and prevent or delay secondary diabetic complications such as those mentioned above.

A blood glucose meter (glucometer) is essential for real-time monitoring of the blood glucose level. For those who cannot afford a costly blood glucose monitoring system, blood glucose can also be monitored by measuring the glucose present in a urine sample; but this method does not provide a real-time measurement. There are two types of blood glucose monitoring systems available on the market: the first utilizes an invasive method that requires a sample of blood from the tip of the finger, and a second non-invasive method that continuously monitors blood glucose levels and is predominantly used by professionals to study the pattern of the blood glucose levels over a long period of time. In this research study the invasive monitoring method was used to measure the blood glucose level in non-diabetic and diabetic individuals.

Heart Rate Variability (HRV) is a non-invasive method to monitor nervous system activity and heart rate fluctuations. HRV refers to the beat-to-beat variations in heart rate. In this study the Physio Toolkit software package was used to extract the HRV signal from ECG recordings, and the Kubios software package was deployed to perform comprehensive HRV signal analysis. This software displays the HRV signal and provides three options to calculate: Time-domain, frequency-domain, and Nonlinear dynamics parameters from raw HRV signals.

Based on previous studies related to abnormal cardiovascular autonomic function it has been observed that glycemia and components of the HRV signal are inversely related [7]. This work documented that diabetics have a lower LF/HF ratio compared to non-diabetics. It is observed that LF and LF/HF values in subjects with hypoglycemia were lower compared to those with normal blood glucose levels [8]. In this research study possible correlation between blood glucose level and LF/HF parameter from frequency-domain results of HRV signal were analyzed in non-diabetic and diabetic individuals.

As it was mentioned above, monitoring blood glucose levels can be challenging for some individuals due to many factors such as cost, eye sight impairment, and decreased coordination; therefore, it is advantageous for an alternative to be identified for monitoring blood glucose levels for these individuals. In this study with simultaneous recordings of ECG and glucose levels in a subject, a correlation between the LF/HF parameter of HRV and glucose level may be derived. In the Framingham Heart Study that was completed by Jogmeet Singh and his group, it was shown that HRV is inversely associated with glucose levels and is reduced in diabetic individuals [8].

It is the hypothesis of this research study that as the LF/HF parameter of the HRV signal increases the blood glucose level for both non-diabetic and diabetic individual decreases.

Chapter 2: Background

In this research study a variety of biomedical instruments and software analysis tools were used to explore the correlation between HRV and blood glucose levels. These devices included a wireless ECG data acquisition device, a glucometer, and various well-tested software packages for analyzing the recorded data.

2.1 Electrocardiography (ECG)

The heart is a muscle that weighs between 7 and 15 ounces. It contains four chambers: the left atrium (LA), right atrium (RA), left ventricle (LV), and right ventricle (RV). The cardiac cycle is a sequence of events that occurs in one complete beat of the heart. The heart's electrical system is made up of three main parts: the sino-atrial (SA) node located in the right atrium of the heart, the atrioventricular (AV) node located on the inter-atrial septum close to the tricuspid valve, and the His-Purkinje system located along the walls of the heart's ventricles. The origin of heartbeat is located in the SA node of the heart, where a group of specialized cells continuously generate an electrical impulse spreading all over the heart muscle through specialized pathways, triggering the process of heart muscle contraction well synchronized between both atria and ventricles. Figure 2.1 shows how the ECG waveform is generated resulting in one heartbeat.

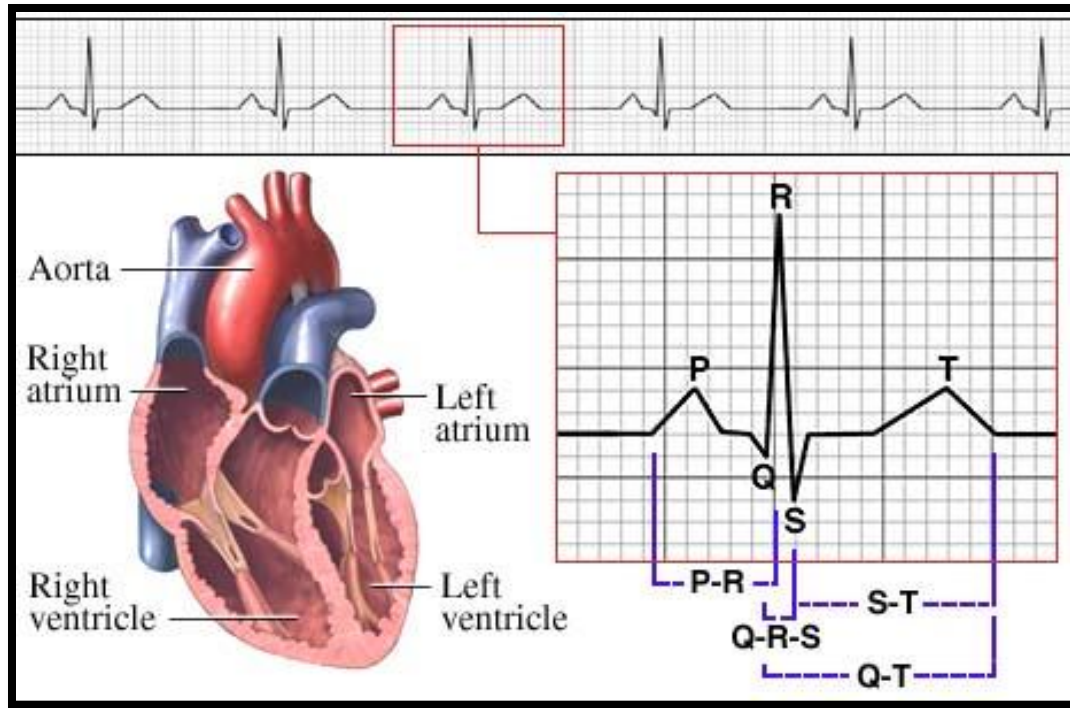


Figure 2.1: ECG waveform generation from the heart [9].

Electrocardiographic (ECG) signals (Figure 2-2) provide the raw data for calculations of the RR intervals, heart rate, and then the derivation of the HRV signals. The time intervals between consecutive heartbeats (from the start of a QRS complex to the beginning of the next QRS complex) are customarily measured in the electrocardiogram. They are named RR intervals. Wireless technology enables a wide variety of new remote monitoring applications. Wireless monitoring systems transmit data via electromagnetic waves at a defined frequency. Radio frequency (RF) transmission is typically used for this type of application. The CleveMed BioRadio device, used in this work, transmits the acquired ECG signal to a computer using a 2.4 GHz carrier signal.

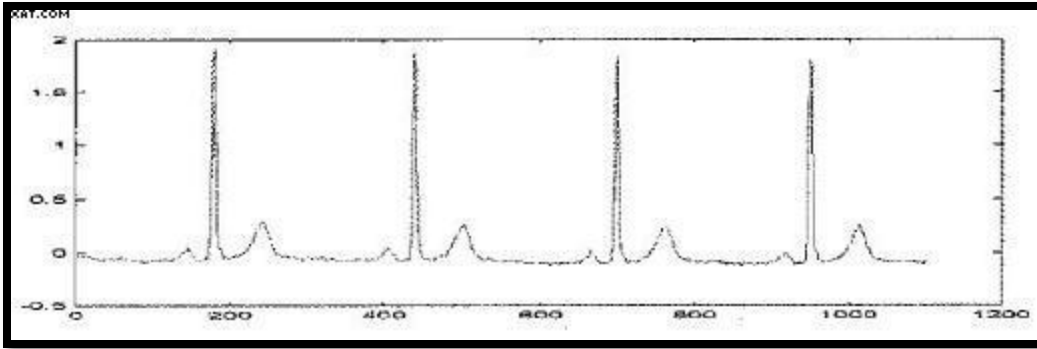


Figure 2-2: Electrocardiogram Signal.

2.2 Heart Rate Variability

HRV signal analysis provides a quantitative marker of the autonomic nervous system (ANS) as the regulation mechanisms of HRV originate from the sympathetic and parasympathetic arms of the ANS [10]. The beat to-beat variations in the heart rate, controlled by the autonomic nervous system, produce the HRV signal (Figure 2-3). The ANS is a part of the nervous system that non-voluntarily controls all organs and systems of the body. There are two branches of the ANS: sympathetic and parasympathetic (vagal) nervous systems. These two systems always work as competitors (antagonists) in their effects on target organs.

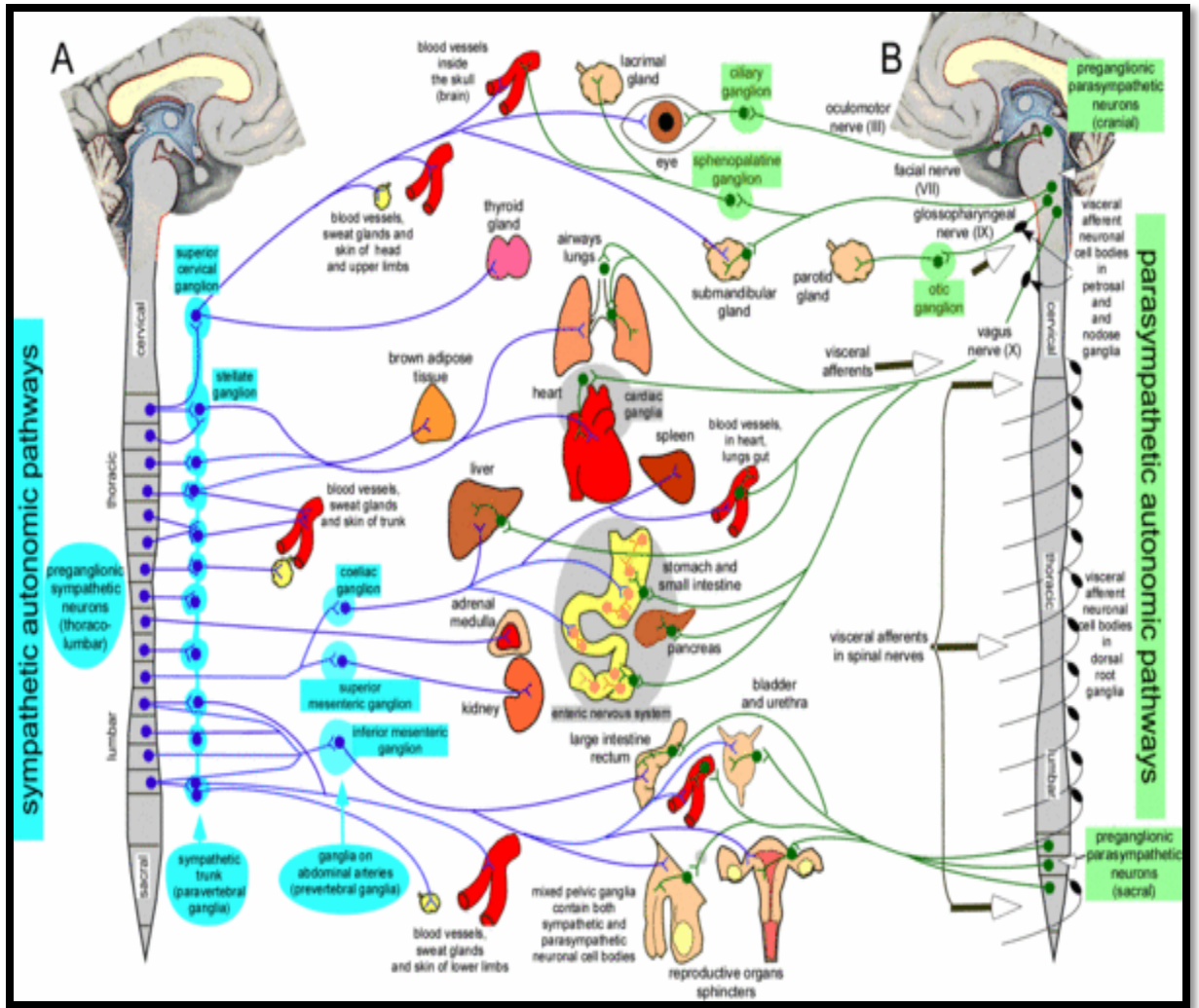


Figure 2-3: Autonomic Nervous System[11].

The sympathetic nervous system (SNS) stimulates the functioning of most organs, including the heart. An increase in sympathetic stimulation causes an increase in heart rate (HR), the amount of blood pumped per each beat (stroke volume), and a narrowing of blood vessels (systemic vasoconstriction). The parasympathetic nervous system (PNS) inhibits the functioning of the organs. An increase in parasympathetic stimulation causes a decrease in HR, stroke volume, and systemic vasodilatation. Various organs in the human body perform their activities under the supervision of the ANS.

In this study RR intervals were determined from the ECG recordings; using the Physio Toolkit Software available at the following website: (<http://www.physionet.org/physiotools>). This software uses a digitized set of ECGs for which QRS complexes (the part of the ECG waveforms immediately preceding the contraction of ventricles) (Figure 2-4) were detected, and their exact time of occurrence within the ECG was recorded.

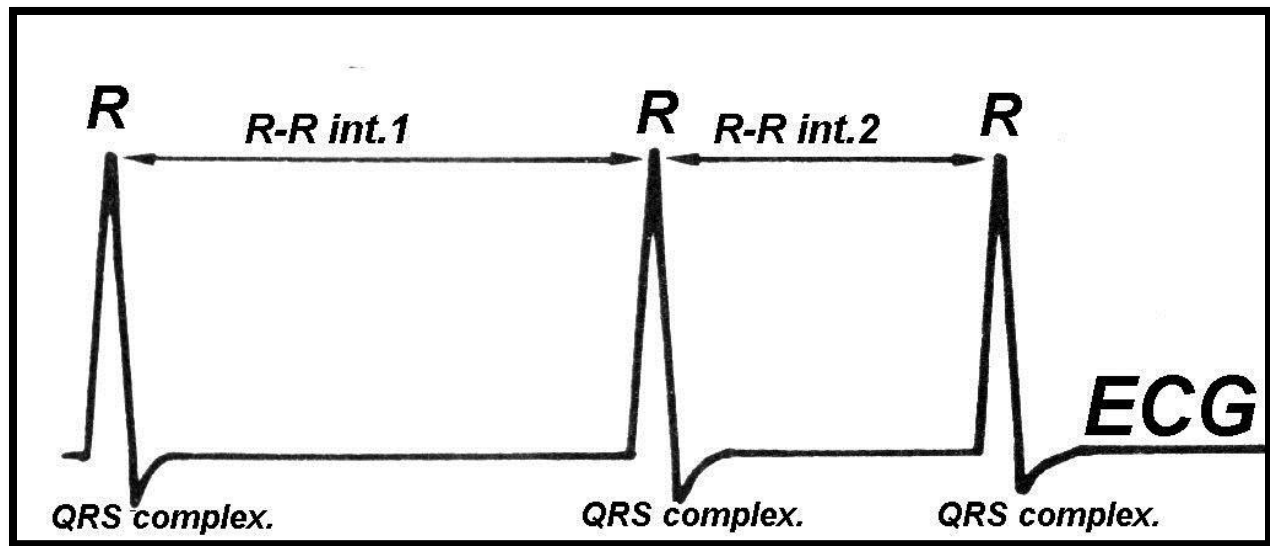


Figure 2-4: RR Interval in ECG Signal.

The frequency-domain result was estimated by resampling of the original RR interval time series to convert them to equidistantly sampled time series as described in section 3.5, followed by applying the Fast Fourier transform and Autoregressive methods. In the frequency-domain results section of the software package that was used in this study, the power spectrum density components could be found: low frequency (0.04-0.15 Hz), high frequency (0.15- 0.40 Hz), and the ratio of low frequency (LF) to high frequency (HF). The LF/HF is an index that relates the balance between sympathetic and parasympathetic components of the ANS also called the sympathovagal balance (Figure 2-5).

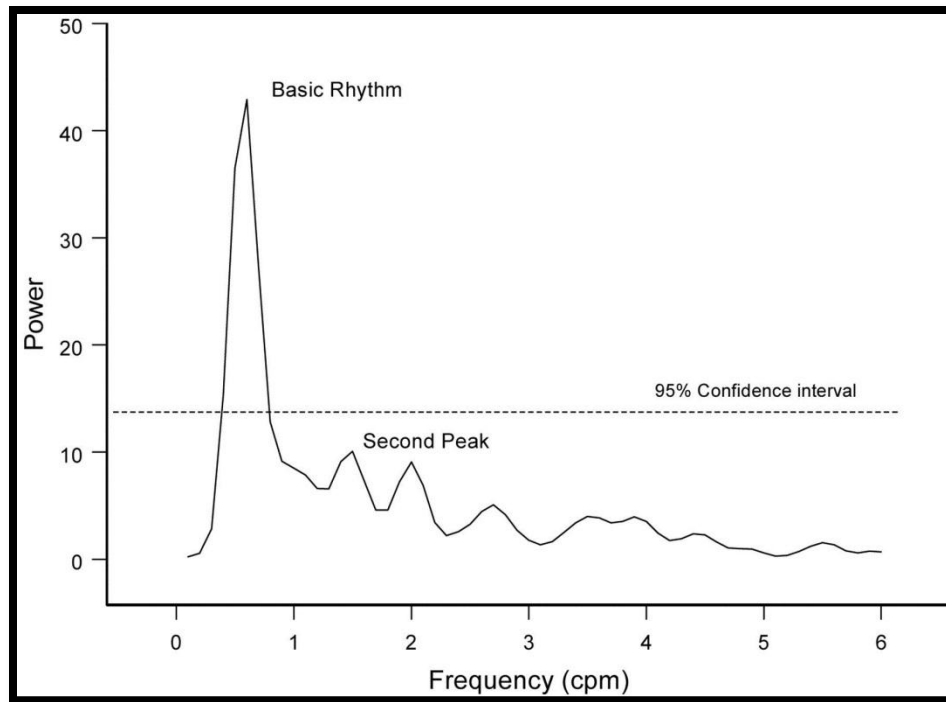


Figure 2-5: HRV Power Spectrum (AR).

2.3 Blood Glucose Regulation and Monitoring

The liver, ANS, and certain glands of internal secretion called endocrine glands maintain the body's blood glucose at normal levels.

- 1) Liver: The liver is at the center of this mechanism and serves as a storehouse of the blood glucose supply. Food is digested and broken down into simpler chemicals that are absorbed from the gastrointestinal tract, carried to the liver, and there built up (synthesized) by the liver cells into a complex compound called glycogen. In the fasting state glycogen is constantly being broken down in the liver cells into a less complex chemical called glucose or sugar that is then liberated into the blood stream at such a rate as to maintain the blood glucose level at around 80 mg. per 100 cc. This breakdown of liver glycogen is controlled chiefly by the ANS.

- 2) Autonomic Nervous System (ANS): The ANS is so called because it is not under direct voluntary control; it regulates involuntary functions such as digestion, intestinal movements, heart rate, blood pressure, breathing, and body temperature. In general, the action of the sympathetic division is to facilitate and hasten the breakdown of liver glycogen with subsequent elevation of the blood glucose level, and the action of the parasympathetic division is to favor the synthesis and storage of liver glycogen. The two divisions are thus essentially antagonistic, and the blood glucose level will be the resultant of these two opposing forces [4].
- 3) Endocrine Glands: The most important organs in blood glucose regulation are the pancreas and the adrenals, both of which are under the control of the pituitary gland. The pancreas secretes the hormone insulin, which brings about the storage of glycogen and thus prevents the development of hyperglycemia (an insufficiency of insulin). Hyperglycemia occurs when there is an excessive amount of glucose in the blood, and hypoglycemia is the result of low levels of glucose in the blood. The adrenal glands produce a hormone, adrenalin, which acts on the liver to facilitate the breakdown of liver glycogen with a subsequent elevation of the blood glucose level. Adrenalin works in conjunction with the sympathetic nerves [4].

The glucometer help individuals maintain their blood glucose level within a range as close to normal as possible. This allows diabetics to feel more comfortable and reduces the risk of long-term complications from diabetes [12]. In this study the Bayer 7393 Contour USB blood glucose monitoring system was used to monitor blood glucose levels in non-diabetic and diabetic individuals (Figure 2-6).



Figure 2-6: Bayer 7393 Contour USB glucometer.

2-4 HRV Analysis Tool

The Kubios HRV Analysis software package available from the following link (<http://kubios.uku.fi/>) was used to analyze the variability of heartbeat intervals. It has an easy-to-use graphical interface that shows the HRV waveform and calculates the time-domain, frequency-domain, and non-linear dynamics parameters from the raw HRV signal (Figure 2-7).

In the frequency-domain results section of the software, the calculated low frequency (LF), high frequency (HF), and the ratio of LF to HF parameters could be found.

Chapter 3: ECG Acquisition and HRV

3.1 Institutional Review Board (IRB)

A research study that uses human subjects requires review by and approval from an Institutional Review Board (IRB). The IRB at the University of Texas at El Paso is responsible for the oversight of the ethical use of human subjects in research activities conducted by the University. In the IRB forms and documents the investigators must specify who will be involved in the research, the purpose of the project, what benefits or harms may result from participating in the research, and the site(s) at which the project is (are) to be carried out. Along with the IRB proposal, a consent form needs to be prepared for the volunteers to read and sign to show their agreement to participate in the project. After completion of the required forms, all documents were submitted to the IRB for review by the board. The data acquisition phase of the project began after approval was obtained from the IRB. The IRB approval letter can be seen in Appendix E.

3.2 Subjects Demographics

3.2.1 Non-Diabetic Demographic

Five non-diabetic individuals with the age range of 22 to 27 years old, weight range of 140 to 240 lbs., male subjects, with White and Latino background participated in this research study. Table 3.1 shows the individuals' demographic.

Table 3.1: Non-diabetic individuals' demographic.

#	Age	Weight	Gender	Ethnical background
1	26	220	Male	White
2	22	240	Male	Latino
3	27	190	Male	Latino
4	25	140	Male	White
5	21	170	Male	Latino

3.2.2 Diabetic Demographic

5 diabetic individuals with age range of 23 to 28 years old, and weight range of 130 to 360 lbs., both female and male genders, with White and Latino backgrounds participated in this research study. Table 3.2 shows the individuals' demographic.

Table 3.2: Diabetic individuals' demographic.

#	Age	Weight	Gender	Ethnical background
1	24	130	Male	White
2	27	320	Female	White
3	28	360	Male	Latino
4	23	240	Male	Latino
5	28	280	Female	Latino

3.3 ECG Data Acquisitions

3.3.1 BioRadio 150

ECG data was collected from volunteers during a 30 minutes session under different glycemic conditions. A wireless ECG device called BioRadio 150 was used to collect the ECG data. The BioRadio 150 is a battery-operated wireless data acquisition system capable of recording, displaying, and analyzing twelve physiological signals from users in real time. This device allows participants to move freely while monitors their physiological signals on the PC.

The BioRadio 150 consists of two hardware components: User unit, and Computer unit.

1. User Unit: The User Unit will be worn by the subject and is responsible for acquiring the physiological signals from the three sensors attached to chest (R & L sides) and on the lower center of abdomen (Ground or reference electrode). The User Unit is powered by two AA batteries, and is turned on/off with a toggle switch located on the side of the enclosure. A green light indicates when the Unit is on. The user unit will transmit cardiac ECG data wirelessly to the computer unit after it amplifies, samples, and digitizes them. The user unit incorporates wireless technology in the Industrial Scientific Medical (ISM) 902 – 928 MHz band. The user unit is shown in Figure 3.1.

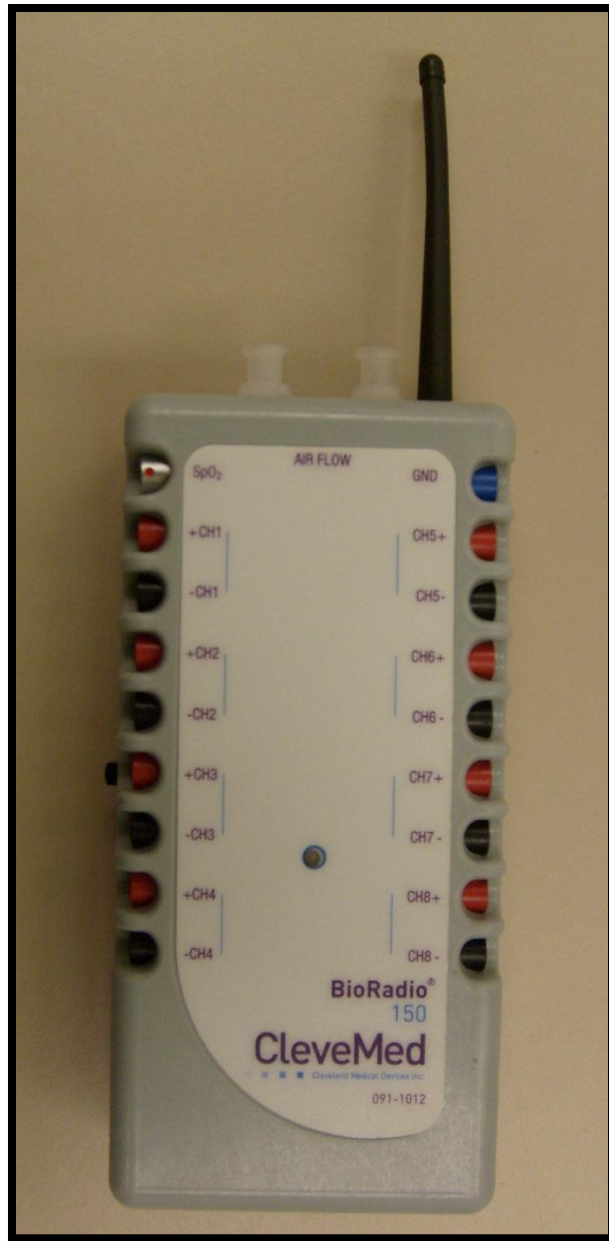


Figure 3.1: BioRadio 150 user unit.

2. Computer Unit: the Computer Unit plugs into the USB port of any PC. The Computer Unit is responsible for receiving the data from the User Unit and sending it to the PC for display and analysis. The Computer Unit is powered from the PC and thus has no external power supply. The PC automatically detects the computer unit once it plugs into

it, and waits for the signal from the user unit. Figure 3.2 shows the BioRadio 150 computer unit.



Figure 3.2: BioRadio 150 computer unit.

3.3.2 BioRadio Capture Lite

The main function of the BioRadio Capture Lite software is to provide a real-time display of frequency analysis, filtering settings and the saving of data. The received data are displayed

on the larger section of the screen, while the device controls, saved data, and DSP filtering and configuration are handled on the smaller right side panel of the display. Figure 3.3 shows a screen shot of the BioRadio Capture Lite user interface.

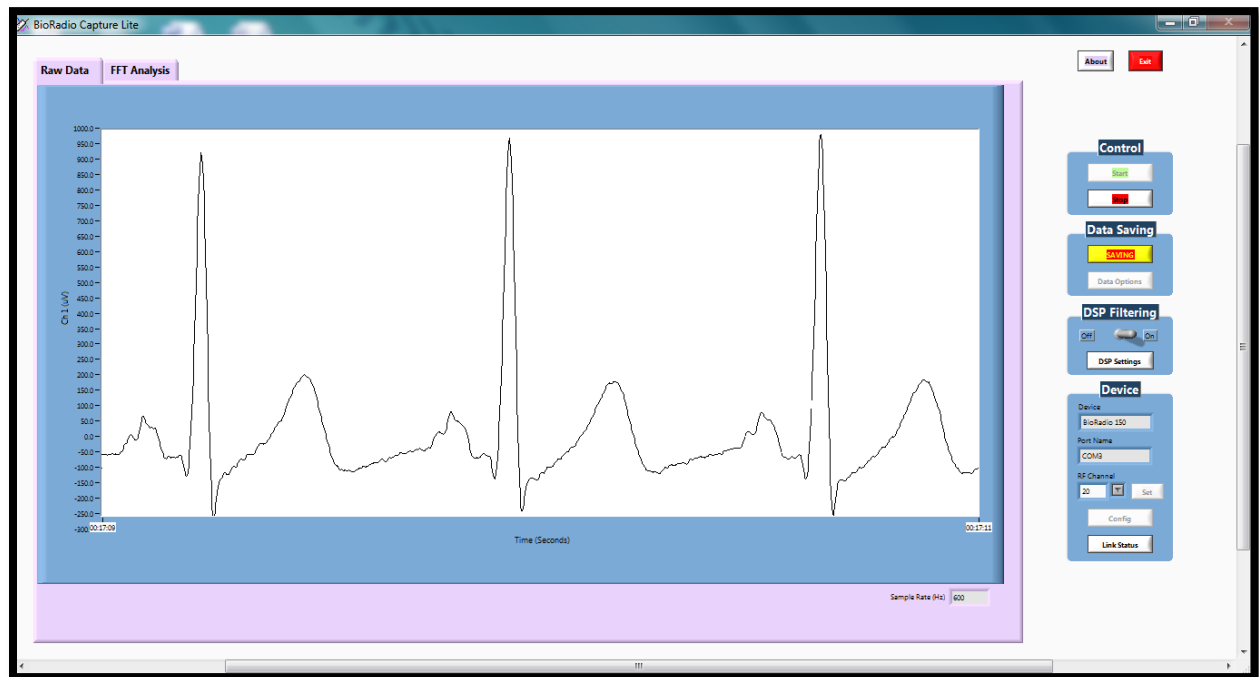


Figure 3.3: BioRadio Capture Lite user interface.

3.4 Determination of Inter-beat (RR) Intervals and Heart Rate Time Series

3.4.1 PhysioBank Compatible File

Once ECG data have been recorded, the inter-beat RR and heart rate time series could be derived using Physio Toolkit software. This software only works with digitized ECG that is already annotated beat by beat. In other word each QRS complex must be recognized along with its time of occurrence.

Since the ECG data have been digitized by BioRadio 150, this section of the study began by making a PhysioBank compatible record. A sample was written into a file in text format in one column of decimal numbers. Commands 3-1 read a text file name ecg001.txt and made

signal file and a header file names ecg001.dat and esg001.heg. The -F and -G specify that the signal was sampled at 128 Hertz and has been amplified. The 0 at the end of the command means that the data are located in the left column (column 0).

```
wrsamp -F 128 -G 102.4 -i ecg001.txt -o ecg001 0
```

 (command 3-1)

3.4.2 Beat Annotation File

In this step the command 3-2 was used to find the exact time of occurrence of QRS complexes in ECG data. Once they have been found, they were saved in the beat annotation file (ecg001.qrs).

```
sqrs -r ecg001
```

 (command 3-2)

The sqrs command finds QRS complexes in the ECG signal in the ecg001 record. This command uses an algorithm for QRS detection; this algorithm used an adaptive threshold and information on the slope of the signal to differentiate between noise and QRS complexes [13]. The function that the sqrs command uses was saved in the WFDB library, and if the sampling frequency in the input header file was different than 250 Hz, it resampled the input signal at 250 Hz.

3.4.3 Inter-beat Intervals (RR) & Extraction from Annotation Record

The time duration from the initial upward deflection of the QRS complex (R wave) to the next R wave in QRS complex is named RR interval. It is preferred to use the R-wave peak as a reference point instead of the start point of the QRS complex. This causes smaller measurement

error since it is hard to locate the start of a QRS complex in a small amplitude or noisy ECG signal.

Command 3-3 reads the annotation record and makes a time series of RR intervals.

```
ann2rr -r ecg001 -a qrs      (command 3-3)
```

Command 3-4 writes the RR intervals in a text file (ecg001.rr1.txt) as a standard output.

```
ann2rr -r ecg001 -a qrs >ecg001.rr1.txt      (command 3-4)
```

Figure 3.4 shows the stages of Physionet software that was explained in this section.

Appendix F shows the steps above using a file called example.

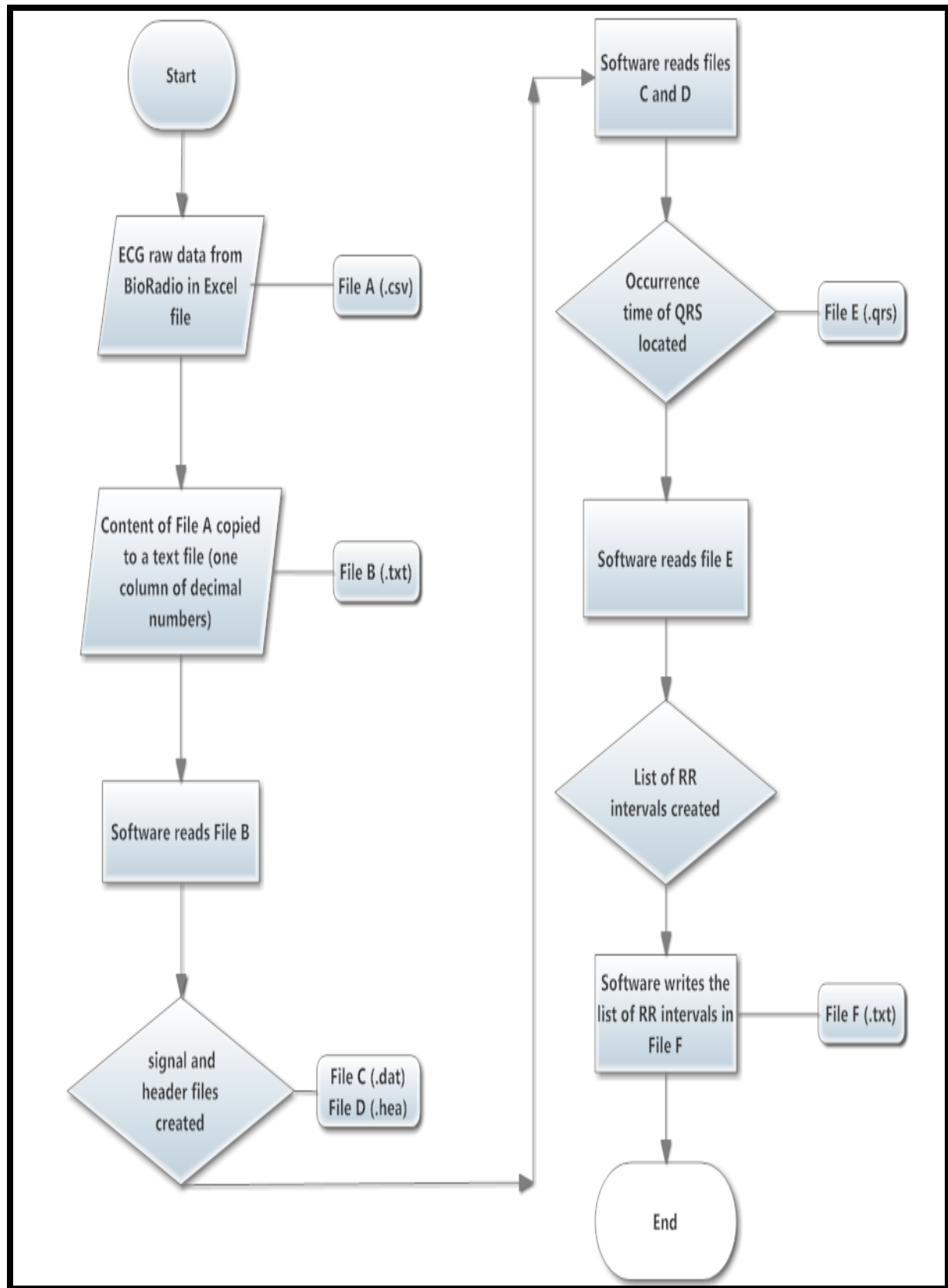


Figure 3.4: Physionet HRV Toolkit steps.

3.5 HRV Analysis Tool

Once the RR intervals have been extracted by using the method that was explained in Figure 3.4 and illustrated in Appendix F, the software package Kubios HRV was used to analyze the variability of heartbeat intervals. This software shows the time-domain and frequency-domain parameters of HRV. This software uses both Fast Fourier transform and Autoregressive spectral modeling to provide the frequency domain analysis to the user. Kubios HRV software is made by Biosignal Analysis and Medical Imaging Group (BSAMIG) at the University of Kuopio in Finland.

3.5.1 QRS Detection

In order to detect QRS complexes there are two steps that need to be followed: preprocessing and decision rule. Preprocessing consists of a bandpass filtering process (approximately 5 to 30 Hz) to reduce interference components such as noise and baseline wander. Once the preprocessing part has been completed the decision rule part determines if a QRS complex has occurred. The decision rule process involves an amplitude threshold that is adjusted adaptively during the QRS detection process. The average heartbeat period is often utilized during this process. Usually the R-wave will be chosen as a fiducial point and the resultant time instance will be given as the output of the QRS detector [14].

The accuracy of the R-wave occurrence time estimate is often required to be 1-2 ms and, thus, the sampling frequency of the ECG should be at least 500-1000 Hz [10]. A distortion can occur within the HRV analysis due to the inaccuracies in R-wave time intervals if we use any sampling frequency smaller than 500 Hz. The estimation accuracy can be improved by

interpolating the QRS complex by using a cubic spline interpolation [15]. However, when the SA node impulses are of interest there is an unavoidable estimation error of approximately 3 ms due to fluctuations in the AV nodal conduction time [16].

3.5.2 Derivation of HRV Signal

The derivation of the HRV time series can be carried out after the QRS complex occurrence times have been detected (3.5.2). The RR intervals can be estimated as the time difference between two successive R-wave (peaks). The n 'th RR interval can be estimated by $RR_n = t_n - t_{n-1}$. The RR intervals and their corresponding time series are shown as a function of time (t_n , RR_n). Before the frequency domain analysis starts it is important to keep in mind that the time series for RR intervals are not equidistantly sampled. To avoid this issue several methods are discussed in the following paragraph.

The first method is to assume that the time series had been equidistantly sampled and evaluate the spectrum from the RR intervals' tachogram. The disadvantage of this method is that it will result in the distortion of the spectrum, and it cannot be considered as function of frequency but rather of cycles per beat [17]. Kubios HRV software applies interpolation techniques to translate non-equidistantly sampled RR intervals to equidistantly sampled intervals [10]. One choice for the interpolation method is the cubic spline interpolation [18]. This technique uses a series of unique cubic polynomials to fit between each of the data points (in this case non-equidistantly sampled RR intervals), with the stipulation that the curve obtained be continuous and appear smooth. These cubic splines can then be used to determine rates of changes and cumulative change over an interval [19]. The last method is referred to as delta functions positioned at beat occurrence times [20]. This method falls back on the integral pulse

frequency modulator (IPFM). IPFM is a simple and efficient representation of SA node. In other words, it is an artificial pacemaker that can be used for generating HRV signal [21]. This approach seeks to form the neural modulation of the SA node [16]. Based on this approach a reference level is found by integrating the modulating signal. The integrator will be set to zero after an impulse has been emitted. Finally, by passing the signal through an ideal low pass filter with cutoff frequency of f_{\max} . The resultant continuous signal was sampled and the spectrum can be calculated by a digital Fourier transform [17].

Chapter 4: ECG and Glucose Monitoring Components

4.1 ECG Monitoring

In this research ECG data was monitored in order to acquire an HRV signal. The CleveMed BioRadio 150 system was used to collect ECG data from volunteers.

4.1.1 BioRadio 150 System

The ECG data from human subjects was collected using the BioRadio device that was described in Chapter 3.

4.1.2 Monitoring Electrodes Placement

The BioRadio 150 device records the ECG data from humans. To ensure accurate and clean signals, the electrode patches used to acquire the signal should be placed on clean and stable areas of the skin. The BioRadio 150 uses three electrodes to acquire ECG signal. The type of radiolucent monitoring electrode used in this research study is Ag/ AgCl made by 3M Health Care. Figure 4-1 shows the monitoring electrodes.



Figure 4-1: 3M monitoring electrode.

The area where the patches were placed was scrubbed with a small pad or paper towel to remove dead skin cells. The monitoring electrodes were first attached to the snap-on electrode wires. Electrode wires are shown in Figure 4-2.



Figure 4-2: Electrode wires.

The patches were attached to the left and right part of the chest, and the third patch was attached on the lower center of the abdomen. Figure 4-3 shows the location that patches were attached to the skin.

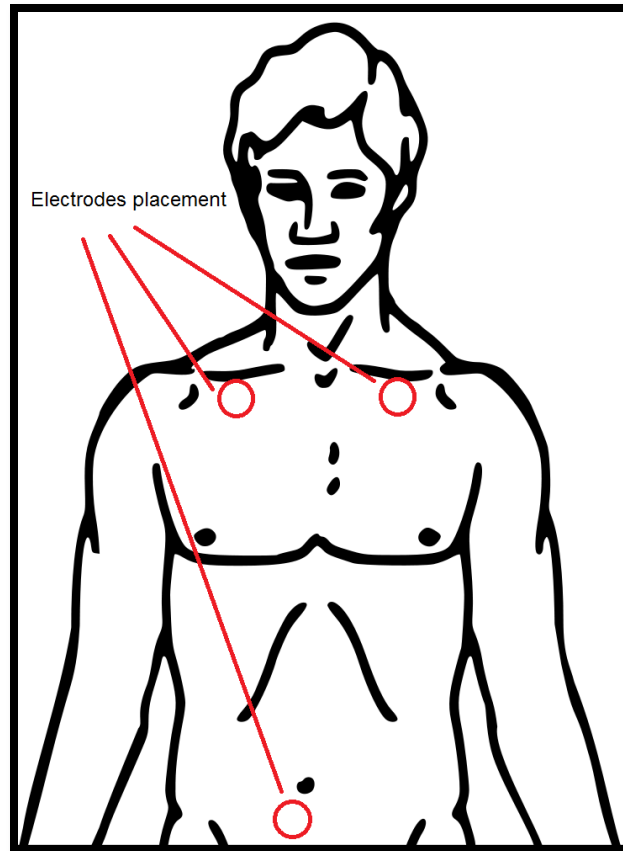


Figure 4-3: Electrode placement for ECG acquisition.

4.2 Glucose Monitoring

The Contour USB blood glucose monitoring system was used by subjects to monitor their glucose concentration in whole blood.

4.2.1 Contour USB Blood Glucose Monitoring System

The Contour USB is a small, easy to use and very fast meter, producing results within five seconds. It connects directly to a PC or MAC, and the meter can store up to 2,000 test results. It is very light and easy to carry in the pocket or purse making it appropriate for the needs of this project. The Contour USB uses a rechargeable battery; has a bright color display that shows average, high, and low readings; and has 500 MB extra memory for storage. Figure 4-4

shows the Contour USB and its components. The meter's battery can be charged with the wall charger or a USB port from a laptop or a PC.



Figure 4-4: Contour USB blood glucose monitoring system.

4.2.2 Test Strips

Contour test strips are intended for self-testing by people with diabetes and by healthcare professionals to monitor blood glucose level. The test provides a quantitative measurement of glucose in the blood from 20 to 600 mg/dL. These test strips require only 0.6 micro liter of blood to conduct the test. Figure 4-5 shows Contour test strip.

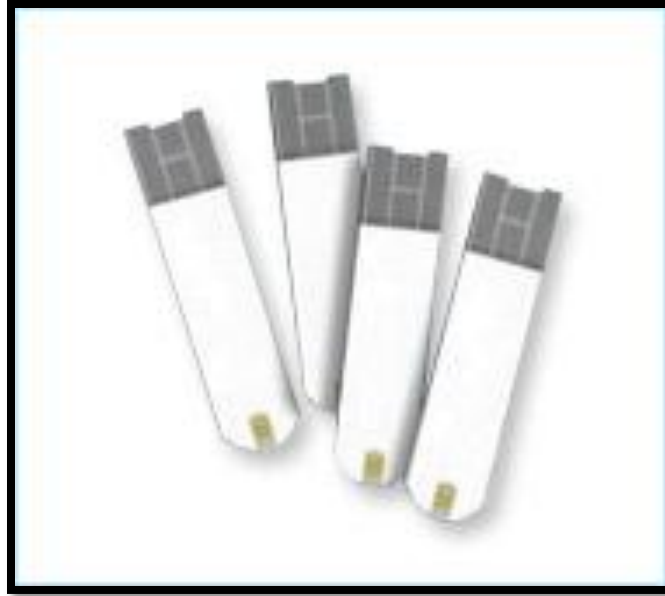


Figure 4-5: Blood test strip.

4.2.3 Microlet Lancing Device

The Microlet lancing device from Bayer is a simple to use lancing device with an improved lancet ejection mechanism. The ergonomic design allows the user to hold the device securely for capillary blood sampling. The lancets are loaded into a lancing device that quickly inserts and removes the lancet. Figure 4-6 shows the Microlet lancing device and a lancet.



Figure 4-6: Microlet Lancing device and Bayer lancets.

Chapter 5: Experimental Methodology

5.1 Relating the HRV to Blood Glucose Level in Non-diabetic Individuals

The data recordings from individuals without diabetes provided control data for comparison of HRV parameters with blood glucose levels. A population sample of five male and female volunteers without diabetes, ranging in age from 21-27 years old, were selected to monitor their ECG and obtain blood glucose level measurements. The volunteers were required to fast for three hours prior to the start of the test. The first blood glucose reading was recorded immediately following the three hour fast, at the beginning of the thirty minute test period; after a five minute wait, the volunteers consumed an eight ounce can of apple juice and a high sugar candy bar, then waited an additional five minutes before the second measurement was performed. Ten minutes later the volunteers consumed a meal consisting of a standard portion of balanced carbohydrates and lean proteins, and waited another ten minutes before the final blood glucose level was obtained.

The BioRadio 150 biosignal acquisition system was used to capture ECG data from the volunteers. Two electrodes on the chest and one under the navel were attached after those areas were cleaned by the ECG abrasive skin prepping gel Nuprep. The subjects were asked to be seated in a chair in a relaxed position and to avoid any sudden movements for the period of thirty minutes. During the data acquisition the user unit of the BioRadio 150 was attached to the volunteer's pocket while their ECG data was transferred wirelessly to the computer unit that was attached to a PC. The ECG data was placed in an Excel file on the computer hard drive for further investigation.

During the blood glucose measurements the subjects were asked to sit in a chair and not perform any activities other than measuring their blood glucose level. The Bayer test strip was inserted into the meter to turn it on, an alcohol pad was used to clean the tip of their finger, and five seconds later a new Microlet lancet was placed in the Microlet lancing device. A proper puncture depth setting was selected by rotating the dial on the endcap ranging from a more shallow puncture for a smaller drop to a deeper puncture for a larger drop. The lancet device was cocked and placed firmly against the tip of the finger. By pressing the blue release button on the top of the lancet device, the sharp head of the lancet poked a small hole in the fingertip. A bead of blood formed by slightly pressing the fingertip. The test strip was then positioned against the bead of blood, and blood entered the strip's receptacle. Five seconds later the reading was displayed on the meter's LCD. The value was recorded, and the used lancet was removed from the lancing device and placed in the bio hazard container.

Once both the ECG data and blood glucose measurements were collected, the ECG recordings were converted into the HRV data sets by using the PhysioToolkit software. After opening the software and entering a command that told the software what function to perform with the data, the ECG signal was then converted to HRV and the resulting data saved as a text file.

The acquired HRV data were analyzed using the Kubios HRV software. The desired HRV file was selected for analysis then the Kubios software provided the time and frequency domain as well as nonlinear dynamics results from the selected HRV data. The outcome was imported and saved as a PDF. The parameters estimated by the Kubios software are shown in Table 5.1.

Table 5.1: List of HRV Parameters.

HRV Parameter	Description
Mean RR	The mean of RR intervals
STD RR	Standard deviation of RR intervals
RMSSD	Square root of the mean squared differences between successive RR intervals
NN50	Number of successive RR intervals pairs that differ more than 50 ms
pNN50	NN50 divided by the total number of RR intervals
VLF FFT	Very low frequency (0-0.04 Hz) estimated by FFT
LF FFT	Low frequency (0.04-0.15 Hz) estimated by FFT
HF FFT	High frequency (0.15-0.4 Hz) estimated by FFT
LF/HF FFT	LF FFT divided by HF FFT
VLF AR	Very low frequency (0-0.04 Hz) estimated by AR
LF AR	Low frequency (0.04-0.15 Hz) estimated by AR
HF AR	High frequency (0.15-0.4 Hz) estimated by FFT
LF/HF AR	LF AR divided by HF AR
ApEn	Approximate entropy

The next step was to find if any correlation could be recognized in the data as blood glucose levels increased. The data were analyzed to find if the glucose levels and the LF/HF parameter varied together. A table consisting of the correlation coefficients is presented in Chapter 6.

5.2 Relating the HRV to Blood Glucose Level in Diabetic Individuals

The recorded data from diabetic individuals helped us to monitor the HRV at abnormal glucose levels. The blood glucose levels of volunteers diagnosed with diabetes were collected using the Bayer's Contour USB meter. The BioRadio 150 was attached to the diabetic individuals in order to collect ECG data. This procedure was performed on five volunteers diagnosed with diabetes.

During the data collection session volunteers were seated in a chair, and the BioRadio 150 and a PC were placed in front of them on a table. A total of three bio-electrodes were attached to their skin after prepping the area using the skin prepping gel to remove dead skin cells. The volunteers were asked to remain in a relaxed position for the period of thirty minutes; any sudden movements may cause unwanted noise in the ECG signal that will cause the QRS complex to be difficult to distinguish. During the data acquisition the user unit of the BioRadio 150 was placed using a clip that attached to the hip pocket of the volunteer's pants while their ECG data were transferred wirelessly to the computer unit that was attached to the PC. The ECG data were placed in an Excel file on the computer hard drive for further investigation.

The Bayer's contour USB meter was used to measure and record the blood glucose level from the diabetic volunteers. Most of the volunteers in this section were familiar with the

procedures to be performed so a very short explanation was given to them at the beginning of the measurements period and the volunteers proceeded to perform their own blood glucose level tests. To turn on the measuring device a Bayer test strip was placed in the meter and the tip of the finger was cleaned using an alcohol pad. The lancet device was prepared by firmly pushing the lancet straight into the lancet holder and re-cocking the spring released mechanism. The amount of pressure applied to the puncture site that affects puncture depth was adjusted, and the Microlet lancet device was positioned against the tip of the finger. The blue release button on the lancet device was pressed, and the sharp head of the lancet created a small hole in the fingertip. To help form the blood drop, volunteers waited a few seconds, then applied gentle pressure using their hand and finger toward the puncture site. Immediately after the blood drop has formed the test strip was then placed against the bead of blood, and blood entered to the strip's receptacle. The puncture site was wiped with a clean, dry tissue, and maintaining pressure on the site until the bleeding stopped, the reading was displayed on the meter after a few seconds. The value was recorded by the researcher, and the volunteers disposed of the used lancets in a bio hazard container to prevent injury or contamination to others.

During the ECG acquisition process it was very important that the volunteers be seated in a comfortable position, and do not make any sudden movements or using a cell phone. (Any unexpected activity could result in an undesirable amount of noise in the recording or distort in ECG recordings making them unusable. In this research we would like to minimize the amount of undesirable noise so the software can easily detect the QRS complexes to provide us with high quality HRV data.)

After both types of data were collected from diabetic individuals, the PhysioToolkit software was used to convert the ECG data to the HRV data. By pressing the software's icon on the desktop to run the program the proper directory was selected, and commands entered to tell the software which function to perform. The PhysioToolkit software then produced and saved the HRV data in a text file on the computer.

The Kubios HRV software was used to analyze the HRV. The software window opens by clicking on its icon on the desktop. The text file that was created in the previous step was imported into the software to be analyzed. This software provided us with fourteen different time-domain, frequency-domain, and nonlinear dynamics parameters; all these results were saved in PDF format to be reviewed later.

In the next step the analyzed data were reviewed to find a correlation between the LF/HF ratio and an increase in glucose levels. The table of correlation coefficients can be found in Chapter 6.

Chapter 6: Results

6.1 HRV Parameters and Glucose Levels in Non-diabetic Individuals

Fourteen different HRV parameters from non-diabetic individuals with glucose levels ranging from 78 to 171 mg/dL were evaluated and normalized to find the degree of variation in individuals' HRV parameters over a thirty minutes interval (Figures 6-1 and 6-2). These two figures show the minimum, maximum, and mean of each parameter. The coefficient of variance was also calculated for those parameters, and Tables 6-1 and 6-2 show those values for non-diabetic individuals with glucose levels ranging from 78 to 171 mg/dL.

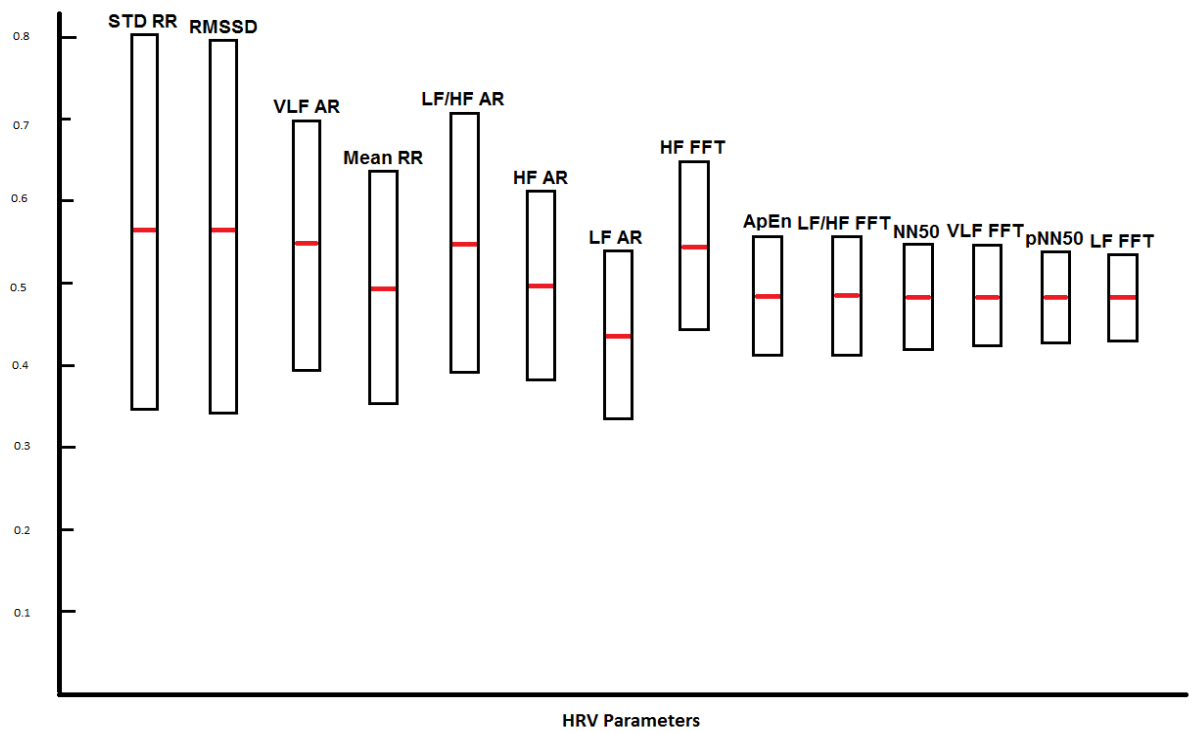


Figure 6-1: Normalized HRV parameters (min, max, and mean) during low glucose level range (78-97 mg/dL) (non-diabetic individuals).

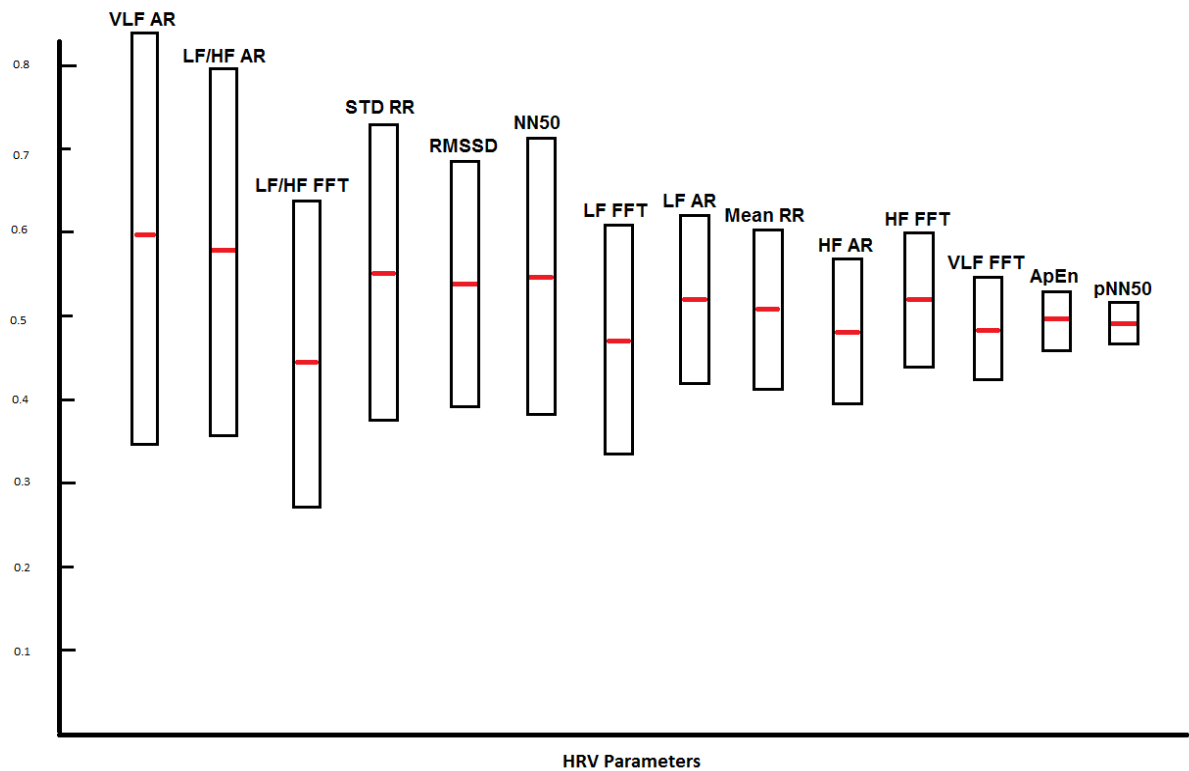


Figure 6-2: Normalized HRV parameters (min, max, and mean) during high glucose level range (148-171 mg/dL) (non-diabetic individuals).

Table 6-1: HRV parameters and coefficient of variance during low glucose level range (78-97 mg/dL) (non-diabetic individuals).

HRV Parameter	Coefficient of Variance (%)
STD RR	33.68
RMSSD	32.52
VLF AR	24.02
Mean RR	23.36
LF/HF AR	22.55
HF AR	17.59
LF AR	16.83
HF FFT	14.73
ApEn	13.45
LF/HF FFT	12.93
NN50	10.04
VLF FFT	9.26
pNN50	7.78
LF FFT	7.08

Table 6-2: HRV parameters and coefficient of variance during high glucose level range (148-171 mg/dL) (non-diabetic individuals).

HRV Parameter	Coefficient of Variance (%)
VLF AR	39.01
LF/HF AR	33.24
LF/HF FFT	32.33
STD RR	30.31
RMSSD	25.59
NN50	24.67
LF FFT	23.03
LF AR	15.55
Mean RR	15.3
HF AR	15.26
HF FFT	12.7
VLF FFT	10.35
ApEn	4.41
pNN50	2.91

Table 6-3: LF/HF ratio in non-diabetic individuals (FFT).

LF/HF ratio (78-97 mg/dL)	LF/HF ratio (148-171 mg/dL)
10.78	0.41
10.40	0.75
7.77	0.73
8.12	0.30
9.78	0.73

Table 6-4: LF/HF ratio in non-diabetic individuals (AR).

LF/HF ratio (78-97 mg/dL)	LF/HF ratio (148 171 mg/dL)
6.05	0.47
9.07	0.75
5.45	0.65
4.90	0.50
6.55	1.11

Table 6-5: Mean \pm standard deviation for LF/HF ratios.

	Mean \pm Standard Deviation
LF/HF FFT 78-97 mg/dL	9.37 \pm 1.21
LF/HF FFT 148-171 mg/dL	0.58 \pm 0.19
LF/HF AR 78-97 mg/dL	6.40 \pm 1.44
LF/HF AR 148-171 mg/dL	0.70 \pm 0.23

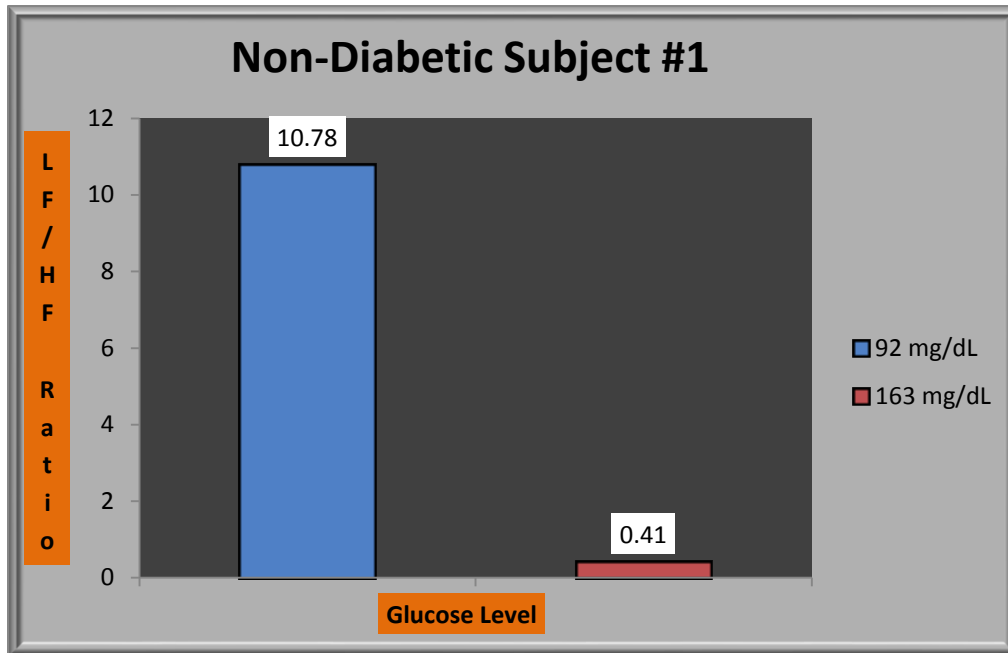


Figure 6-5: Glucose level VS LF/HF ratio using FFT method.

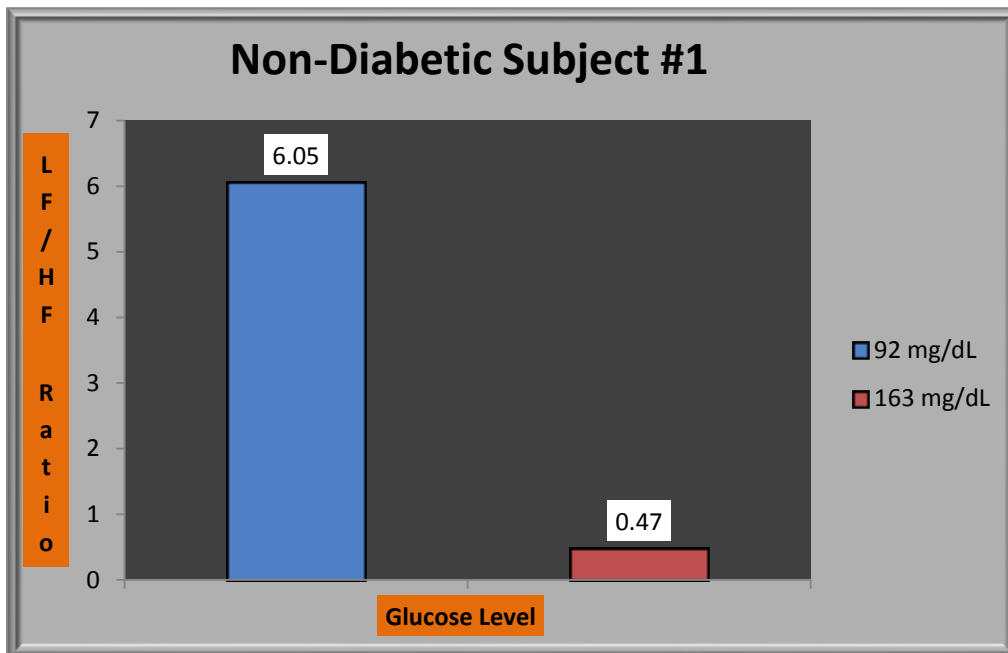


Figure 6-6: Glucose level VS LF/HF ratio using AR method.

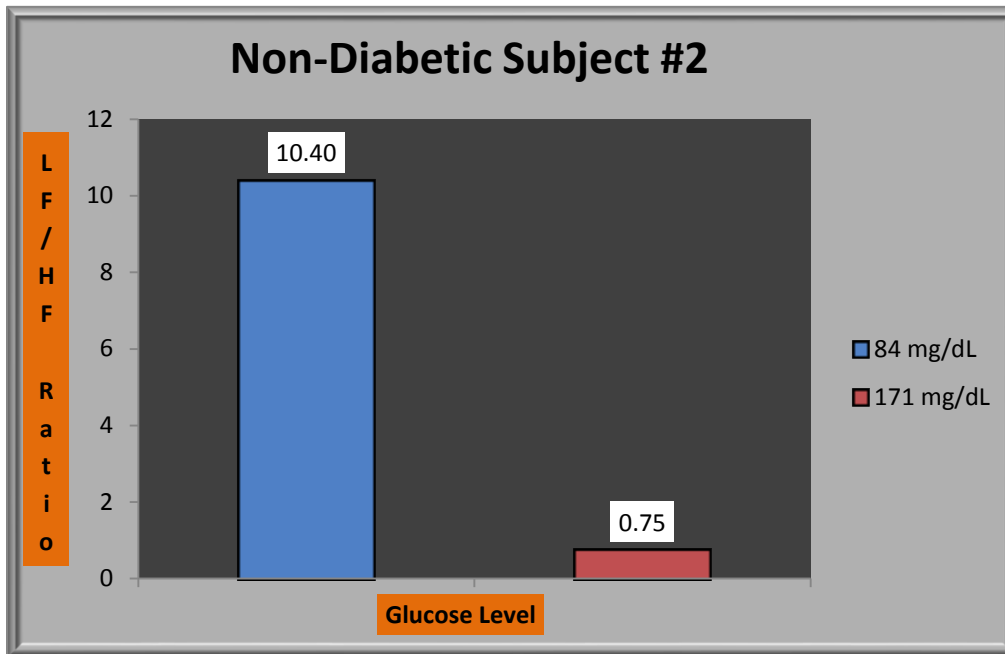


Figure 6-7: Glucose level VS LF/HF ratio using FFT method.

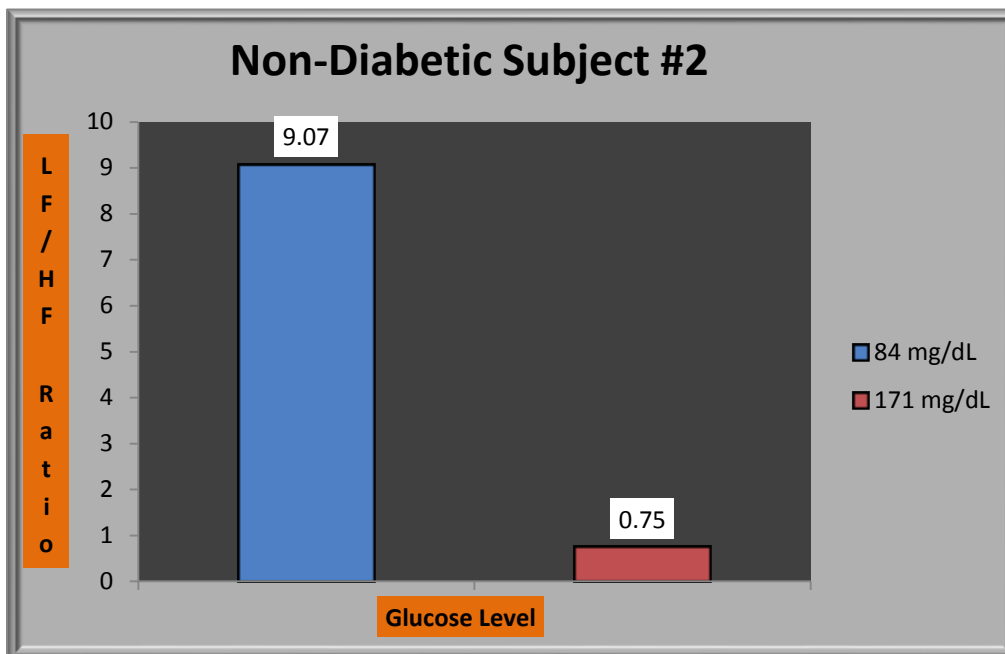


Figure 6-8: Glucose level VS LF/HF ratio using AR method.

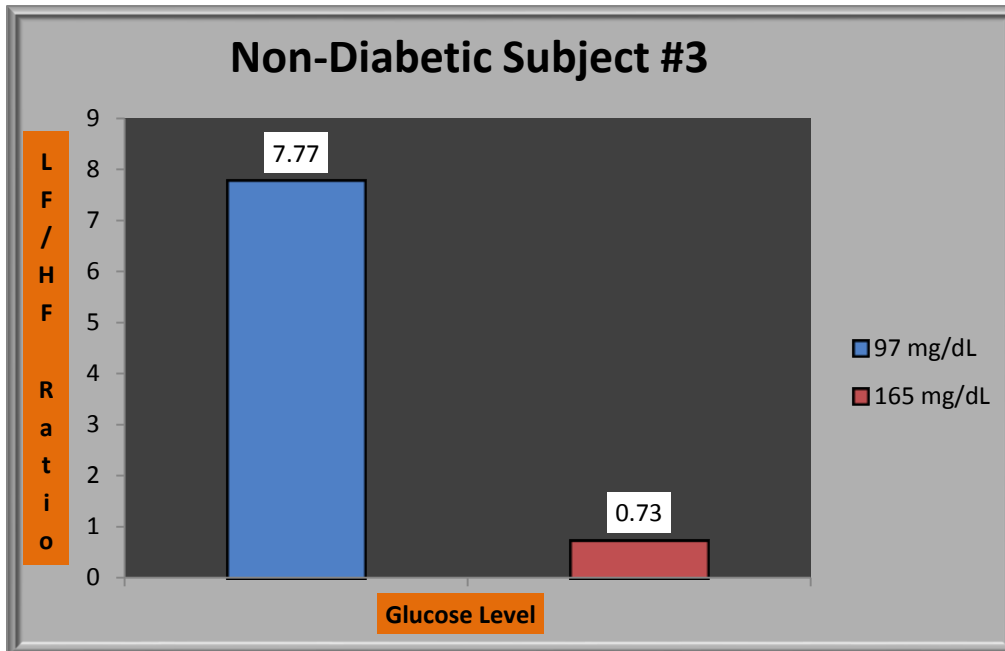


Figure 6-9: Glucose level VS LF/HF ratio using FFT method.

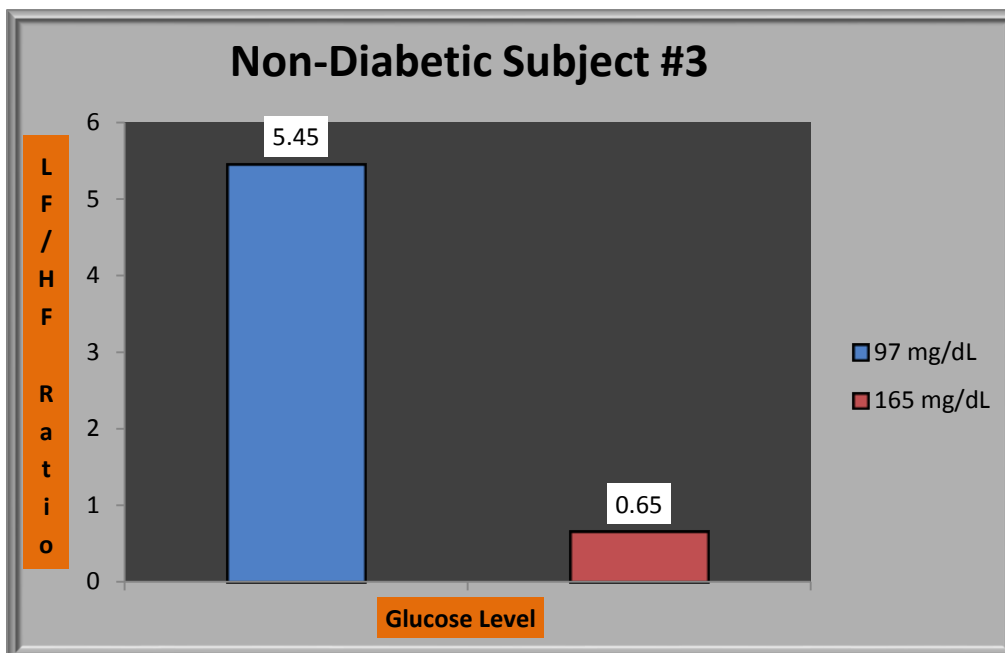


Figure 6-10: Glucose level VS LF/HF ratio using AR method.

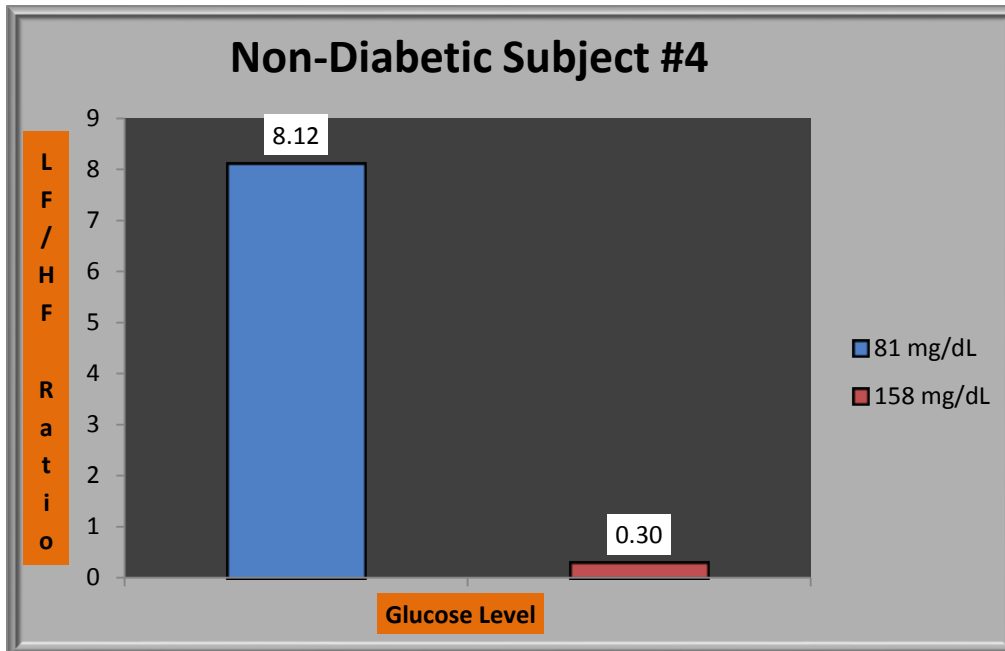


Figure 6-11: Glucose level VS LF/HF ratio using FFT method.

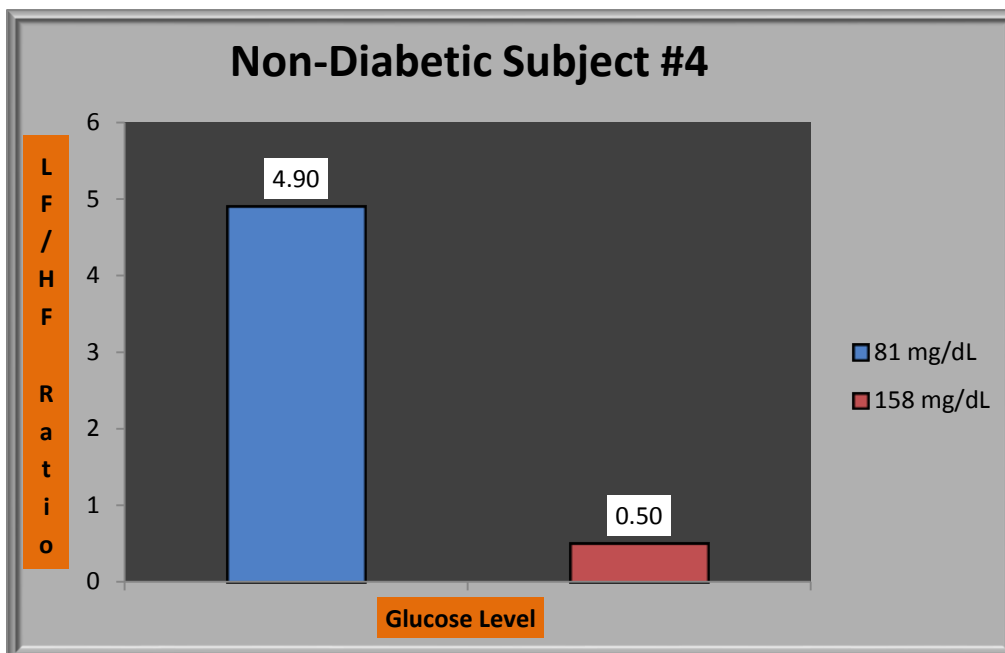


Figure 6-12: Glucose level VS LF/HF ratio using AR method.

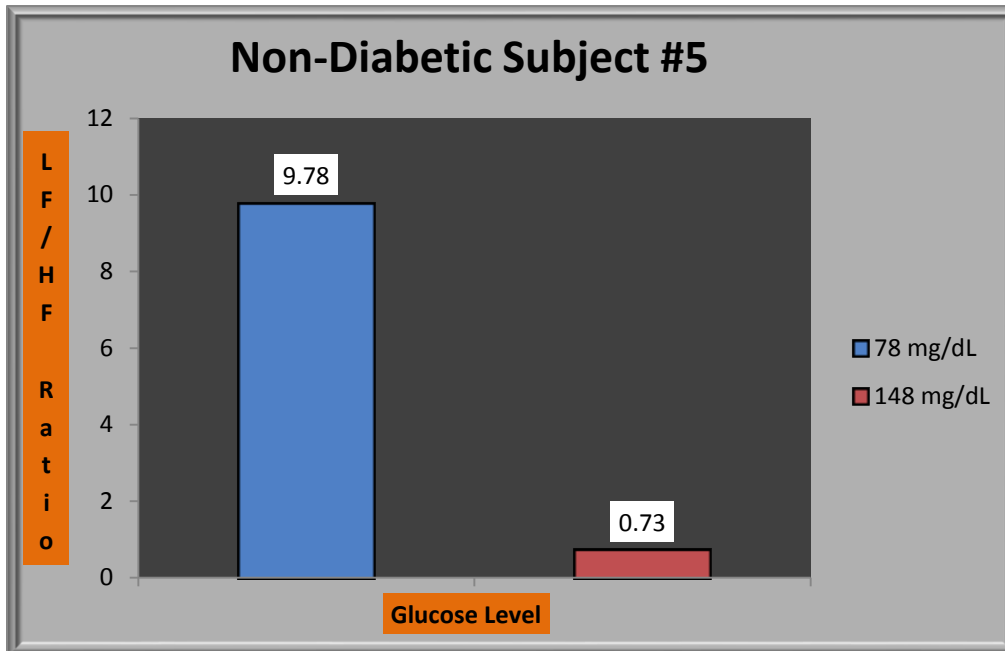


Figure 6-13: Glucose level VS LF/HF ratio using FFT method.

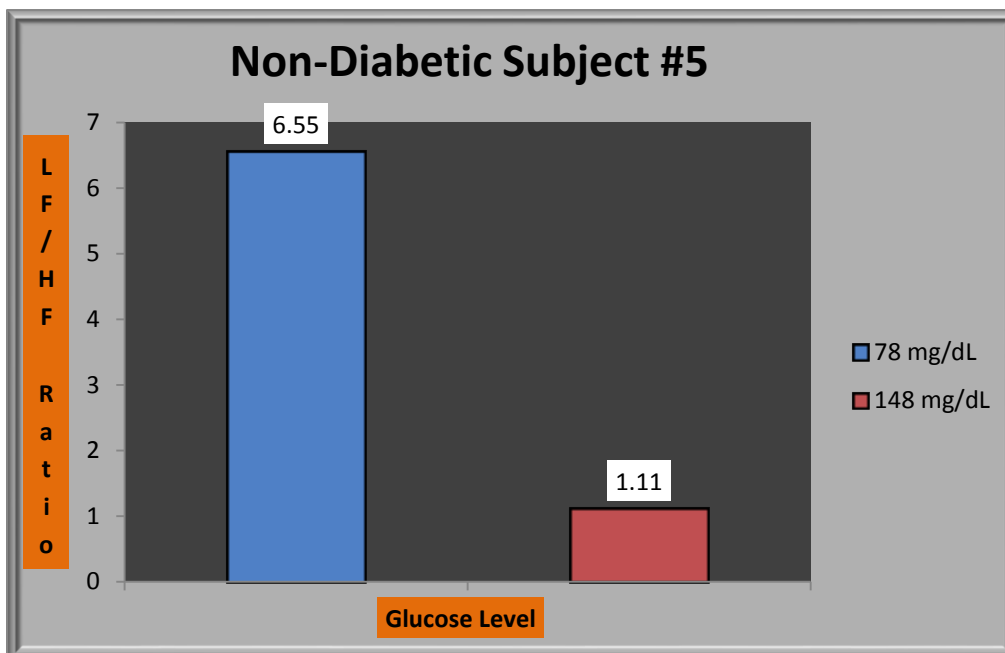


Figure 6-14: Glucose level VS LF/HF ratio using AR method.

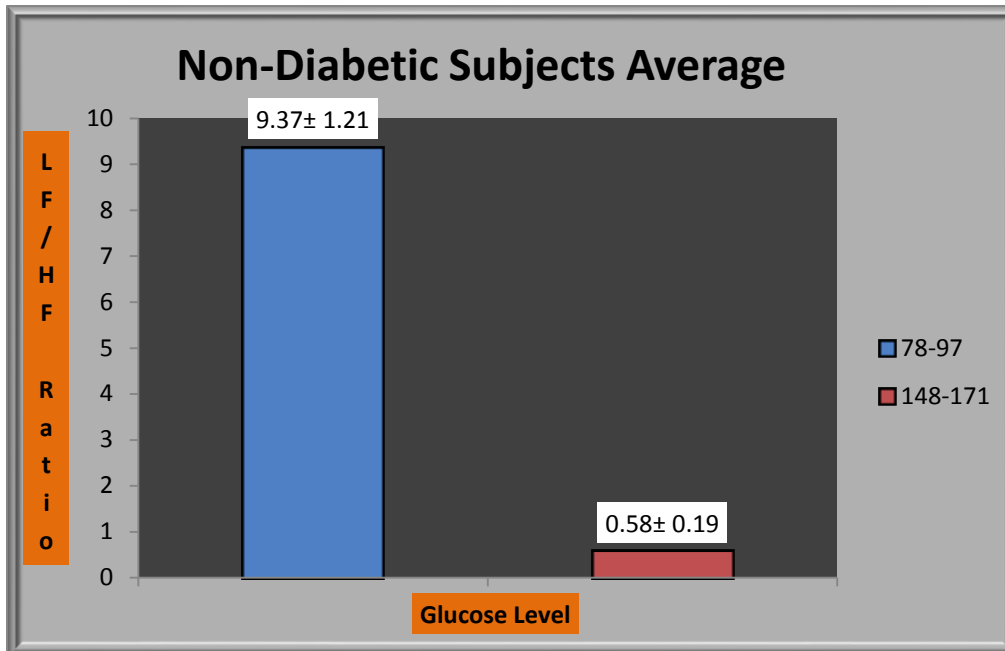


Figure 6-15: Glucose level ranges VS average LF/HF ratio using FFT method.

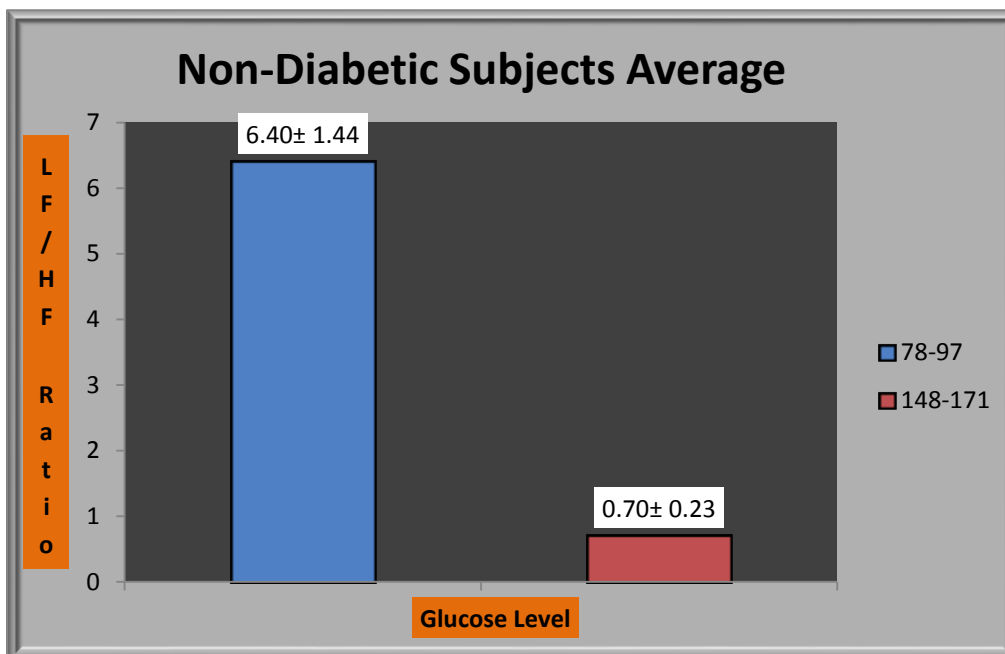


Figure 6-16: Glucose level ranges VS average LF/HF ratio using AR method.

6.2 HRV Parameters and Glucose Levels in Diabetic Individuals

Fourteen different HRV parameters from diabetic individuals with normal and mildly hyperglycemic conditions with glucose levels ranging from 73 to 234 mg/dL were evaluated and normalized to find the degree of variance over a thirty minutes interval (Figures 6-17 and 6-18). These two figures show the minimum, maximum, and mean of each parameter. The coefficient of variance has also been calculated for those parameters, and Tables 6-6 and 6-7 show those values for diabetic individuals with normal and mildly hyperglycemic conditions with glucose levels ranging from 73 to 234 mg/dL.

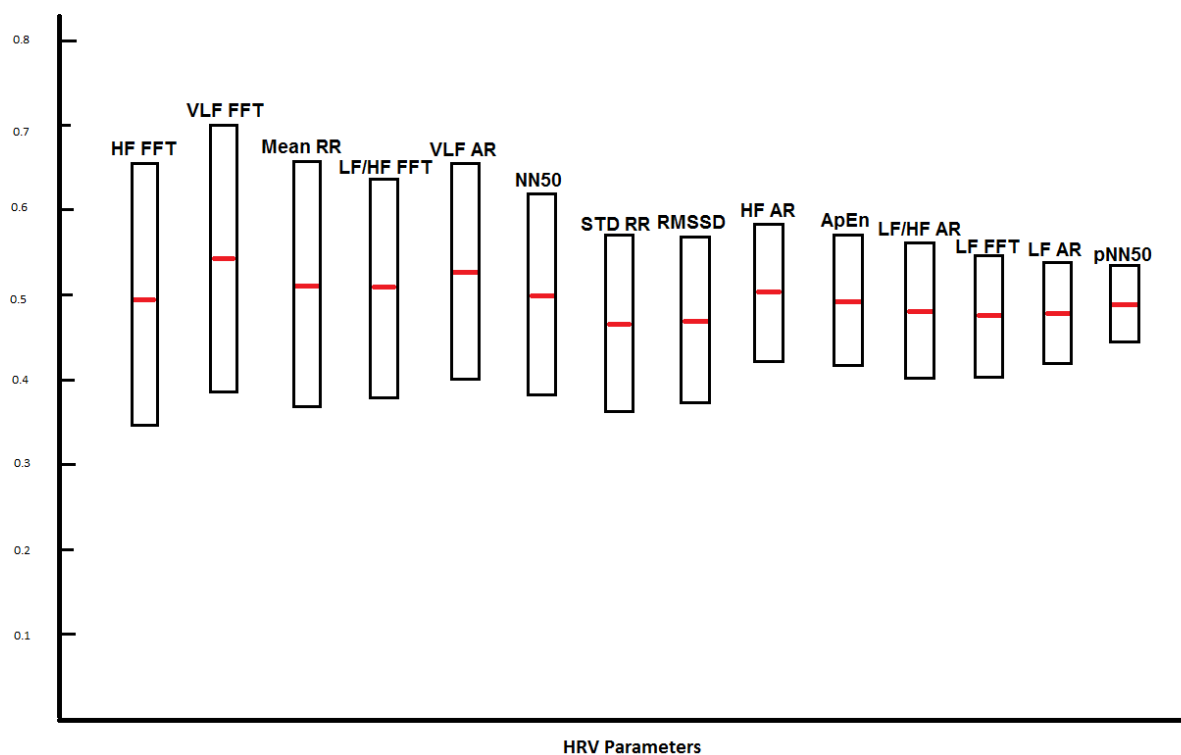


Figure 6-17: Normalized HRV parameters (min, max, and mean) during normal glucose levels ranging from 73 to 146 mg/dL (diabetic).

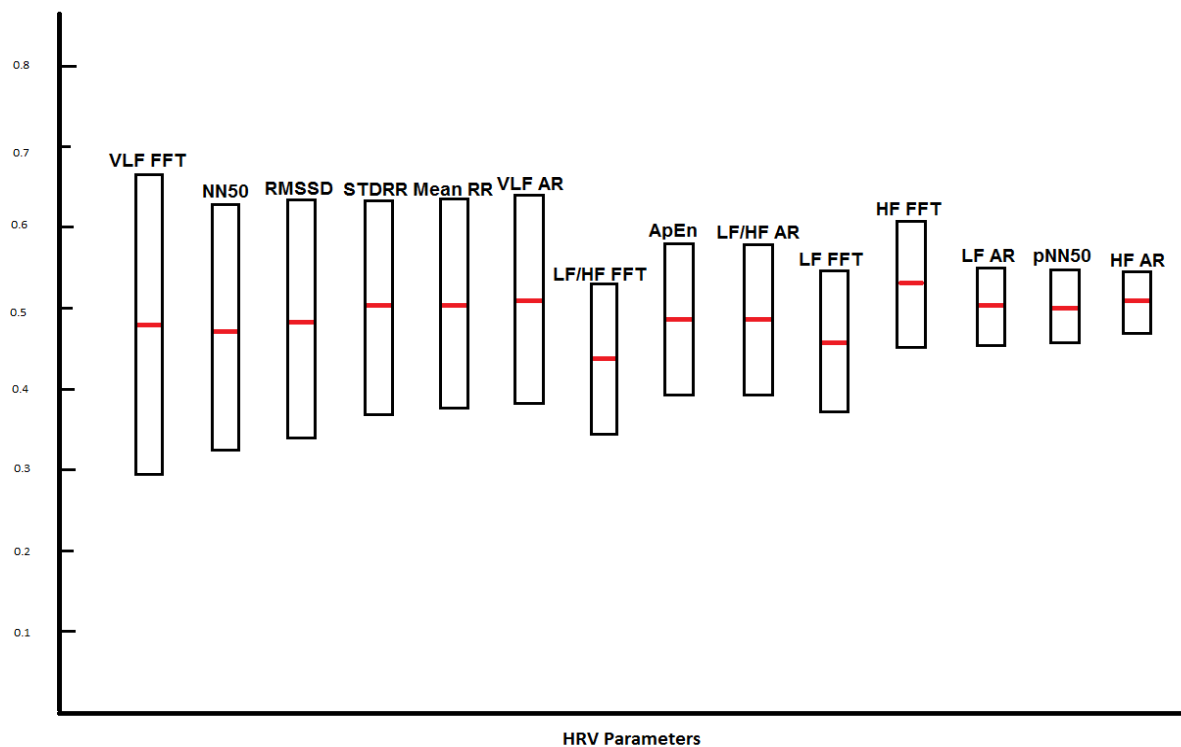


Figure 6-18: Normalized HRV parameters (min, max, and mean) during mildly hyperglycemic condition with glucose levels ranging from 127 to 234 mg/dL (diabetic).

Table 6-6: HRV parameters and coefficient of variance during normal glucose level range (73-146 mg/dL) (diabetic individuals).

HRV Parameter	Coefficient of Variance (%)
HF FFT	23.33
VLF FFT	22.88
Mean RR	20.84
LF/HF FFT	18.57
VLF AR	18.36
NN50	16.83
STD RR	15.98
RMSSD	14.21
HF AR	11.49
ApEn	11.26
LF/HF AR	11.11
LF FFT	10.86
LF AR	7.56
pNN50	5.43

Table 6-7: HRV parameters and coefficient of variance during high glucose level range (127-234 mg/dL) (diabetic individuals).

HRV Parameter	Coefficient of Variance (%)
VLF FFT	25.76
NN50	23.83
RMSSD	23.61
STD RR	21.97
Mean RR	20.24
VLF AR	20.11
LF/HF FFT	19.96
ApEn	15.54
LF/HF AR	13.62
LF FFT	12.36
HF FFT	12.27
LF AR	8.87
pNN50	7.79
HF AR	7.32

Table 6.8: LF/HF ratio in diabetic individuals (FFT).

LF/HF (73-146 mg/dL)	LF/HF (127-234 mg/dL)
2.73	0.85
2.59	0.51
1.67	0.86
1.90	0.59
2.05	0.80

Table 6.9: LF/HF ratio in diabetic individuals (AR).

LF/HF (73-146 mg/dL)	LF/HF (127-234 mg/dL)
2.17	1.13
2.24	0.91
1.63	1.02
1.87	0.78
1.94	0.83

Table 6-10: Mean \pm standard deviation for LF/HF ratios.

	Mean \pm Standard Deviation
LF/HF FFT 73-146 mg/dL	2.19 \pm 0.41
LF/HF FFT 127-234 mg/dL	0.72 \pm 0.14
LF/HF AR 73-146 mg/dL	1.97 \pm 0.22
LF/HF AR 127-234 mg/dL	0.93 \pm 0.13

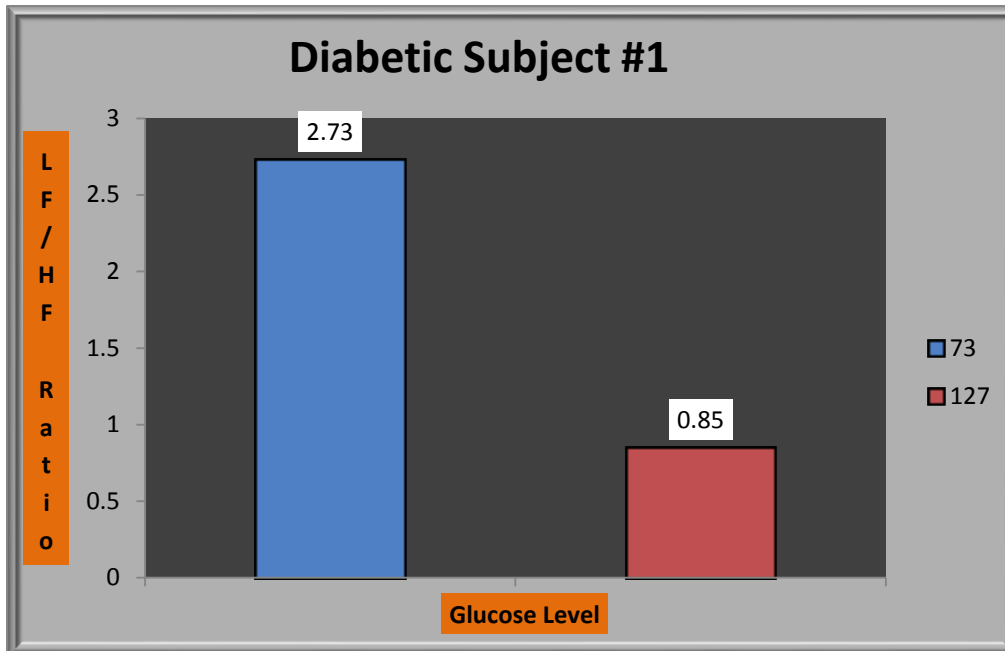


Figure 6-19: Glucose level VS LF/HF ratio using FFT method.

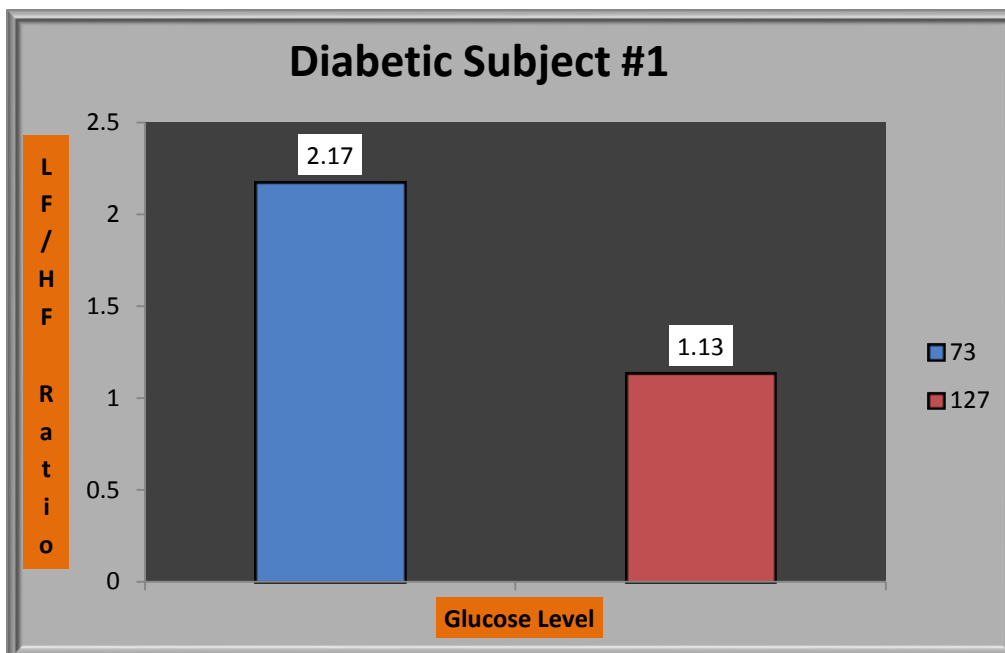


Figure 6-20: Glucose level VS LF/HF ratio using AR method.

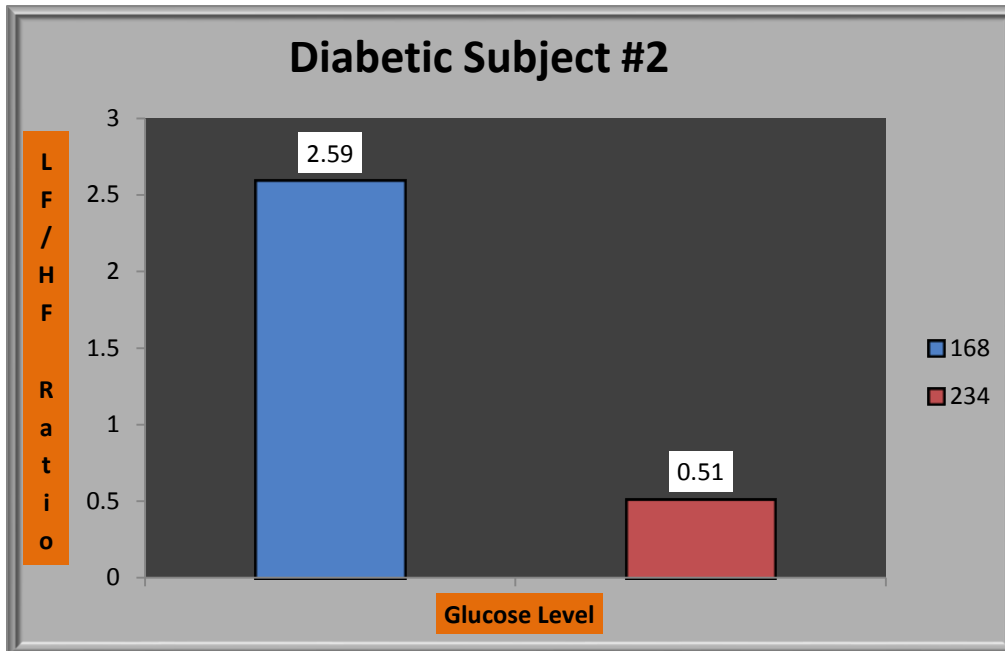


Figure 6-21: Glucose level VS LF/HF ratio using FFT method.

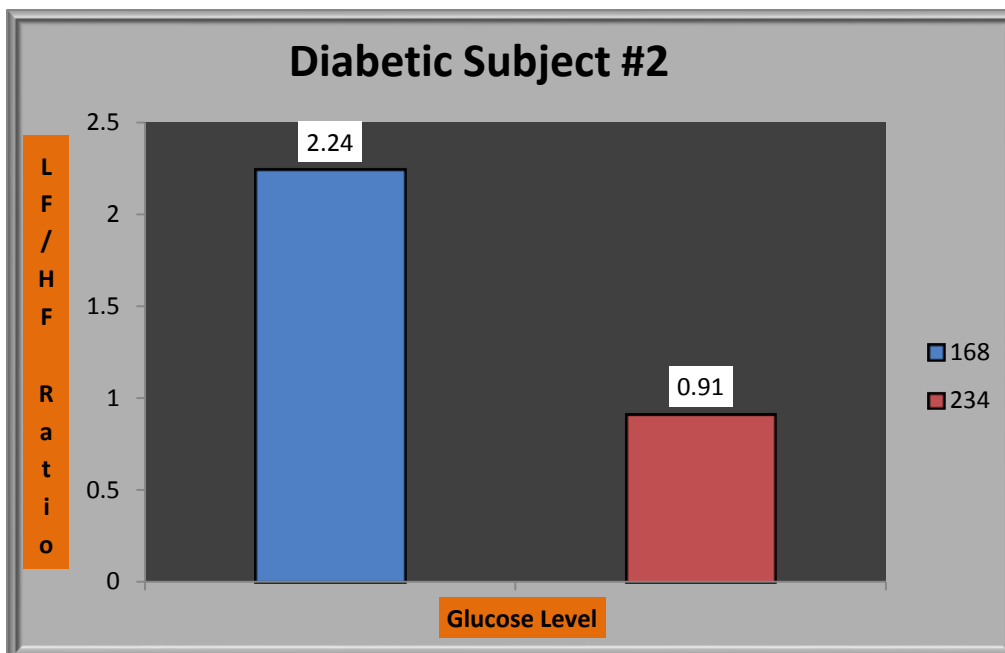


Figure 6-22: Glucose level VS LF/HF ratio using AR method.

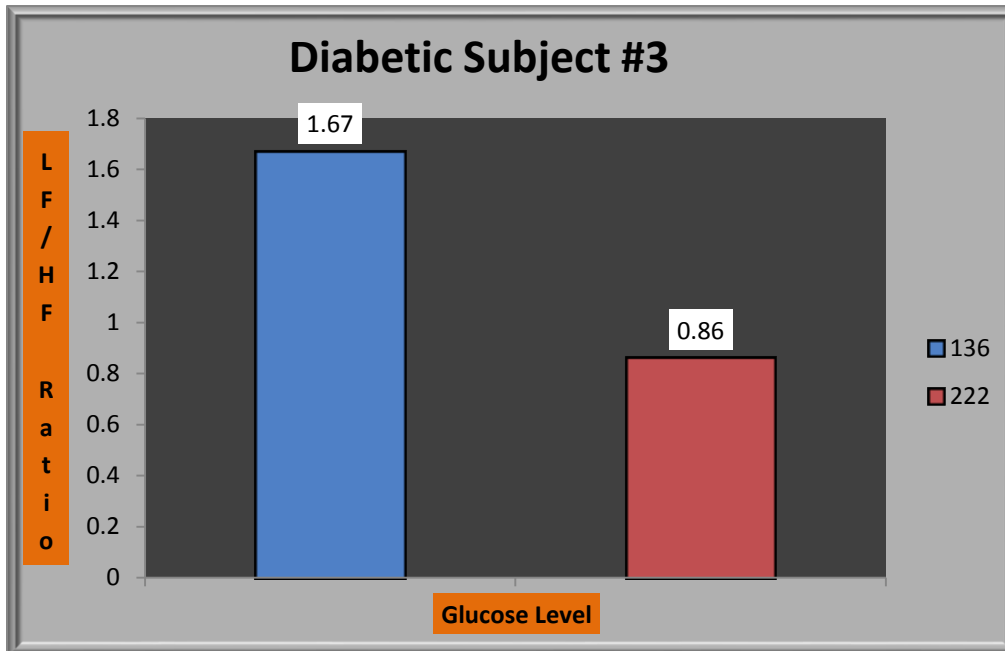


Figure 6-23: Glucose level VS LF/HF ratio using FFT method.

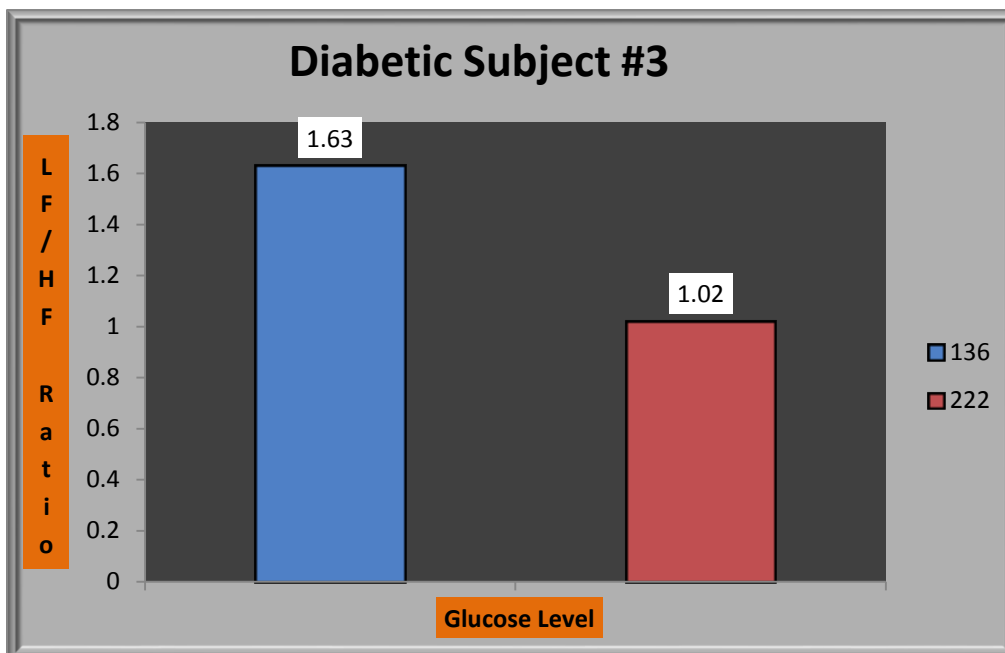


Figure 6-24: Glucose level VS LF/HF ratio using AR method.

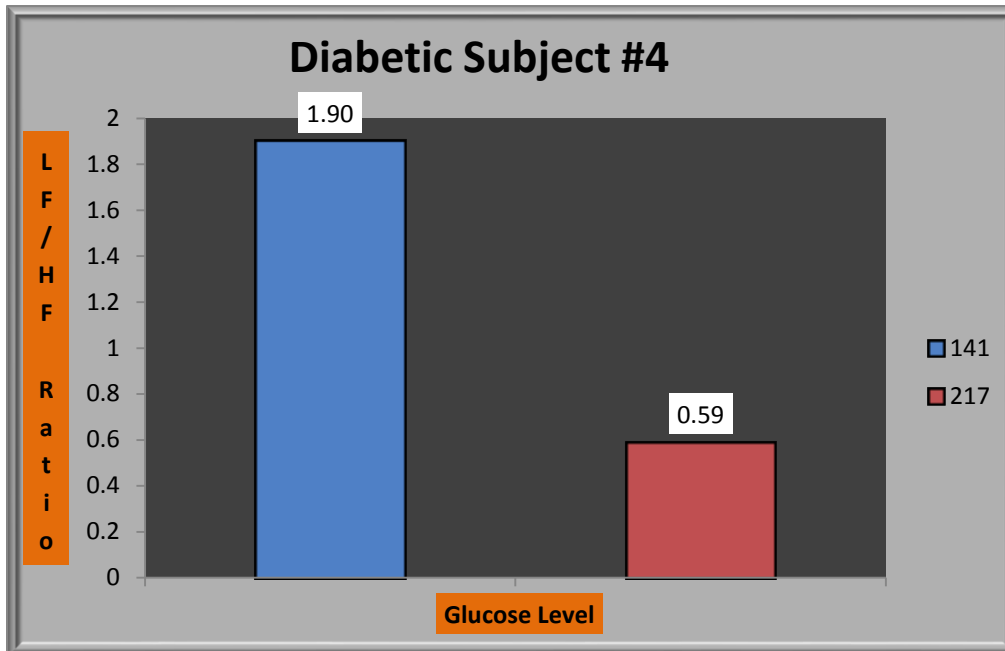


Figure 6-25: Glucose level VS LF/HF ratio using FFT method.

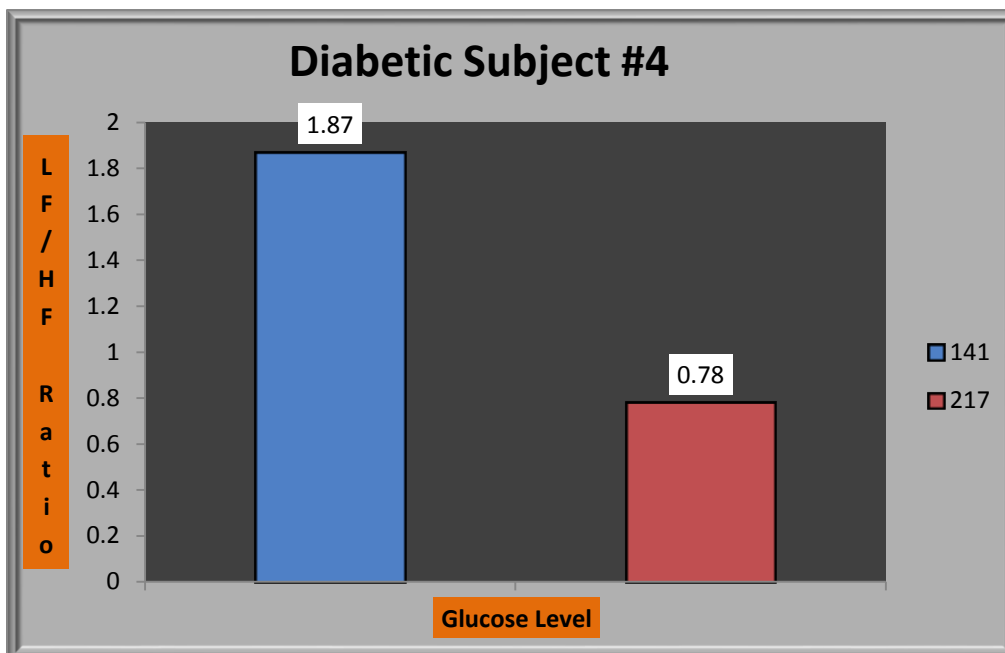


Figure 6-26: Glucose level VS LF/HF ratio using AR method.

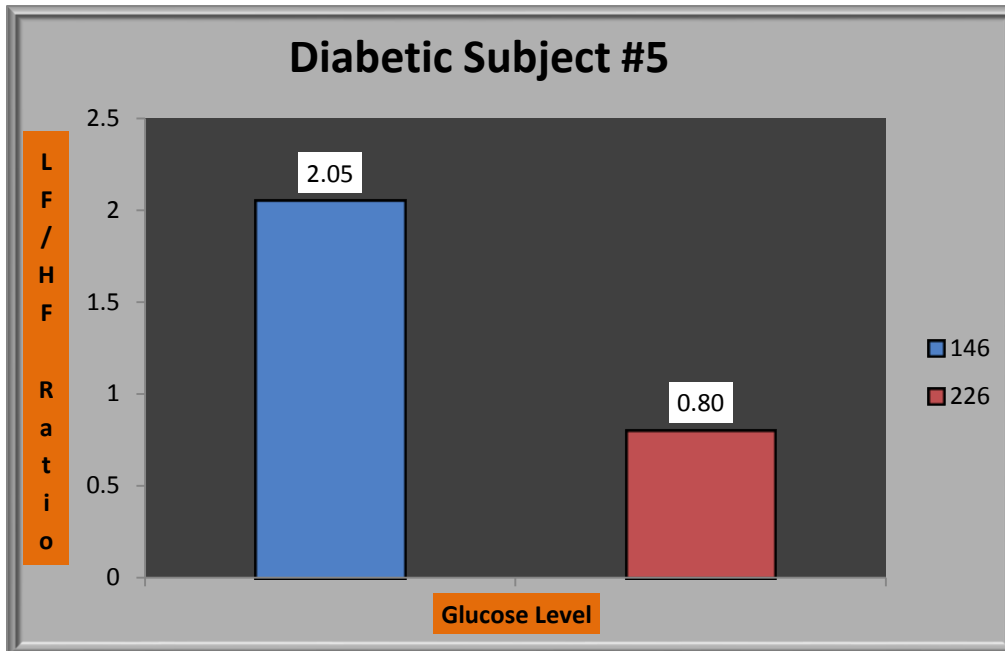


Figure 6-27: Glucose level VS LF/HF ratio using FFT method.

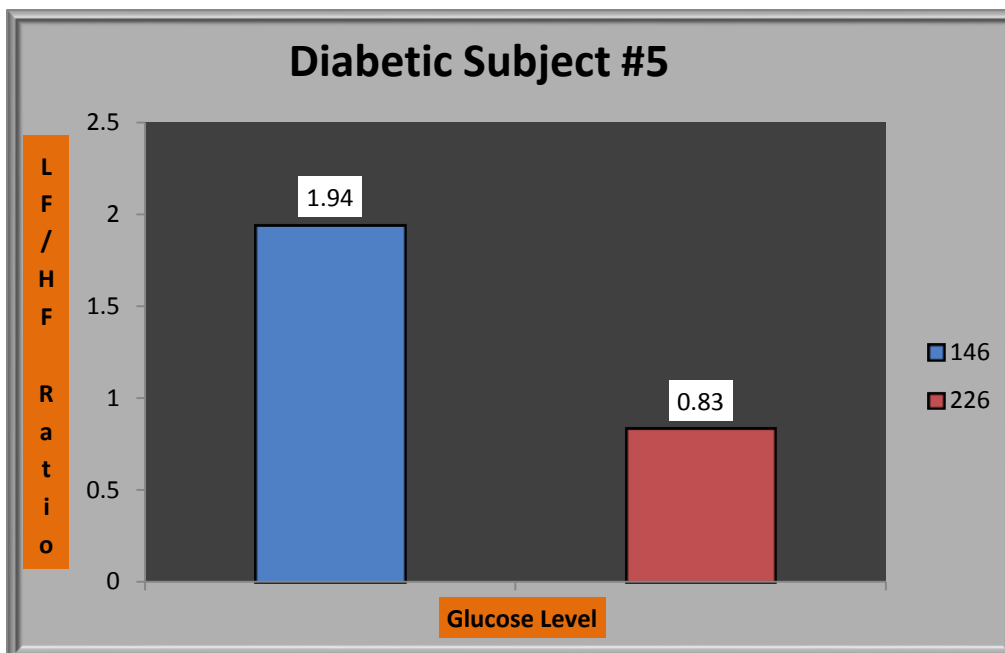


Figure 6-28: Glucose level VS LF/HF ratio using AR method.

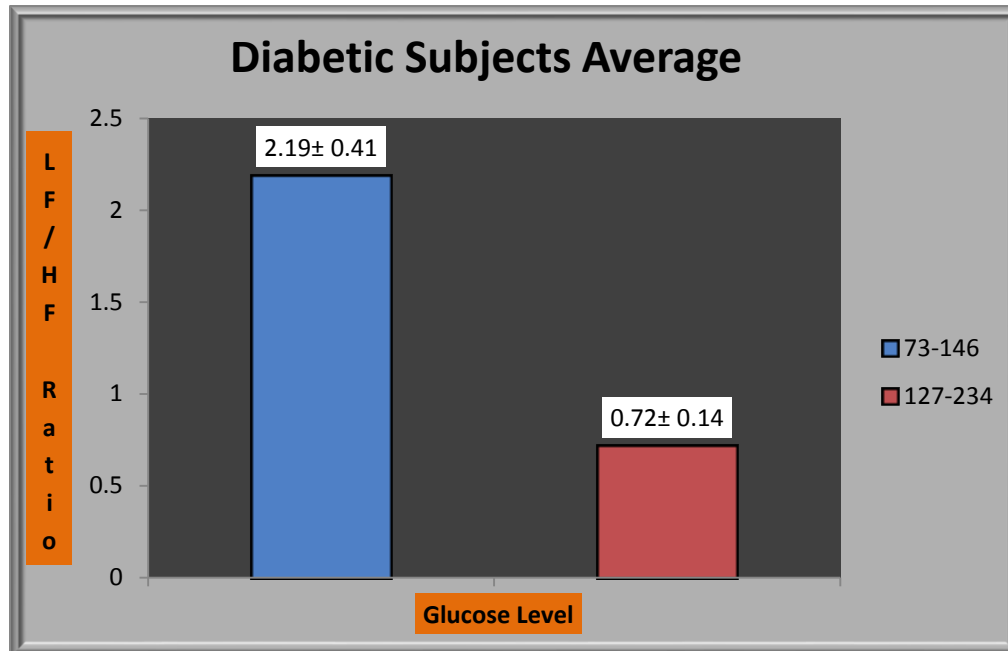


Figure 6- 29: Glucose level ranges VS average LF/HF ratio using FFT method.

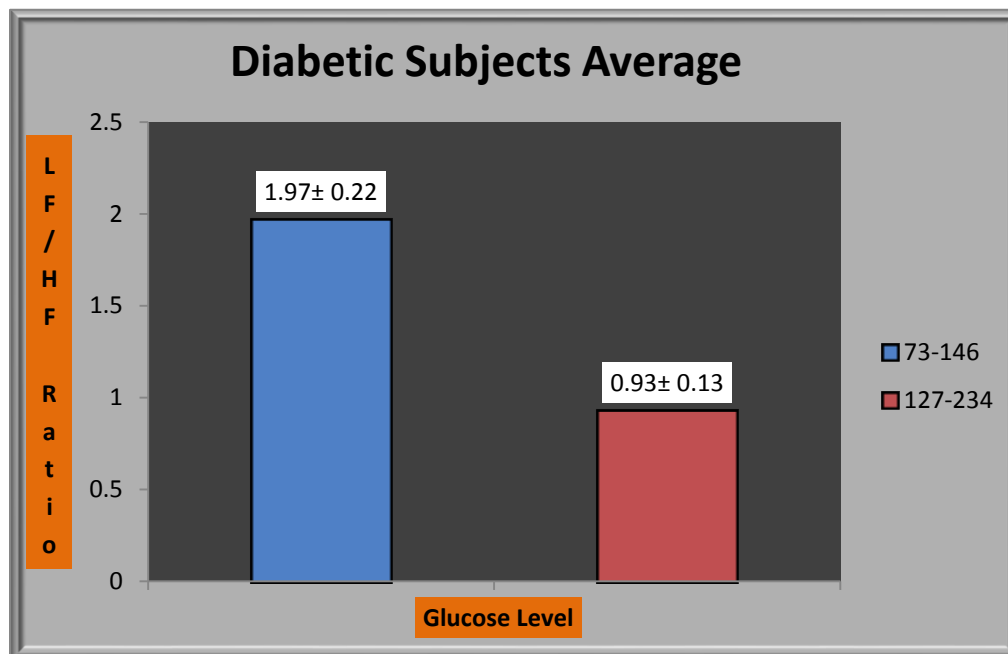


Figure 6.30: Glucose level ranges VS average LF/HF ratio using AR method.

Chapter 7: Discussion

7.1 Comparing the Glucose Level and LF/HF Ratio in Non-diabetic Individuals

Fourteen HRV parameters were calculated and normalized at normal glucose levels ranging from 78 to 97 mg/dL and high glucose level ranging from 148 to 171 mg/dL in non-diabetic individuals. Figures 6-1 and 6-2 show the degree of variance in each parameter at the normal and high glucose levels. The recorded glucose levels did not show any sign of hyperglycemic or hypoglycemic conditions in these individuals.

The coefficients of variance for all fourteen parameters were calculated using the population means and standard deviations. Tables 6-1 and 6-2 show the coefficients of variance for the LF/HF ratios that were calculated based on Fast Fourier Transform (FFT) and Autoregressive (AR) spectral modeling increased during high glucose levels in non-diabetic individuals. Figures 6-1 and 6-2 also verified this rise in variance of LF/HF ratios once the glucose level increased in non-diabetic individuals.

Based on the calculated LF/HF ratios using the FFT and AR methods that are shown in Tables 6-3 and 6-4, a direct correlation between glucose level changes and the LF/HF ratio could be determined from the five non-diabetic individuals. LF/HF ratios measured in the lower end of the normal glucose ranges have higher values compared to the LF/HF ratios measured at the upper end of the non-diabetic individuals' glucose ranges. The column charts of the LF/HF ratios calculated by FFT and AR methods and the glucose levels for the five non-diabetic individuals (Figure 6-5 to Figure 6-14) show a significant drop in the LF/HF ratios while the glucose levels increase.

7.2 Comparing the Glucose Level and LF/HF Ratio in Diabetic Individuals

The calculated HRV parameters' variances during mild hyperglycemic condition within the diabetic study group demonstrated small increase in variance during higher glucose levels. The glucose levels of the diabetic individuals ranged from 73 to 234 mg/dL. Compared to the data of the non-diabetic individuals, the LF/HF ratios calculated by FFT and AR methods in diabetic individuals showed lower variances at the upper end of the glucose ranges (148 to 171 mg/dL for non-diabetic and 127 to 234 mg/dL for diabetic individuals), this dramatic drop in LF/HF variance can be seen in Tables 6-2 and 6-7. Another observation is the standard deviation of RR intervals (STD RR) that decreased significantly in variability in individuals with diabetes. Figures 6-1, 6-2, 6-17, and 6-18 showed that many other parameters changed in variability during different glucose levels in both groups of subjects who participated in this research project. Figures 6-17 and 6-18 show the degree of variance in each parameter at normoglycemic and mild hyperglycemic conditions in diabetic individuals.

Through the analysis of the LF/HF ratio based on FFT and AR techniques (Tables 6-8 and 6-9), an inverse correlation between the glucose level and LF/HF ratio was observed in the HRV data collected from the five diabetic individuals. By comparing the measurements at the normal and mildly hyperglycemic conditions it can be noted that when glucose level increased, the LF/HF ratio decreased in all five diabetic individuals. This inverse correlation can be observed in Figures 6-19 to 6-28. It can be noted that the same correlation, discussed in the previous section of this chapter, was found in five non-diabetic individuals.

Chapter 8: Conclusion

8.1 Comparing the Glucose Level and LF/HF Ratio in Non-diabetic Individuals

The HRV signal and glucose level information collected from five non-diabetic individuals that participated in this research study was helpful to establish a correlation between the non-diabetic individuals' HRV parameter changes and their glucose levels. This was helpful to determine the high glucose level range in a non-diabetic individual if the LF/HF parameter of their HRV signal was low. This research study concludes that in any future research on the HRV signal parameters, specifically on the given range of LF/HF ratio, the HRV value could be used to indicate glucose level in non-diabetic individuals. In order to make a more accurate conclusion it would be preferable to examine a larger population of non-diabetic individuals. This would strengthen the statistical data and help to determine if the conclusion that was made based on this study can be applied to a larger sample population.

In future studies it would be desirable to use the Holter monitoring system to capture ECG signal from participants since this portable device that continuously monitors the cardiovascular system for at least 24 hours would help to reduce the unwanted noise in ECG and record a higher quality signal. In this research the glucose level was acquired by using the traditional finger lancing method that provided only a small number of samples to be analyzed for the investigation. It would be preferable to use a continuous glucose monitoring system such as the Gluowatch device. The participants in this research would suffer a significant amount of pain, and providing subjects with test strips and lancets to conduct more glucose readings would be more expensive.

8.2 Comparing the Glucose Level and LF/HF Ratio in Diabetic Individuals

The HRV and glucose information measured during normal and mild hyperglycemia showed an important characteristic as it can be observed in the LF/HF tables and column charts. The HRV tables show a decrease in LF/HF ratios derived from HRV signals of diabetic individuals at normal glucose levels compared to non-diabetic individuals. It can also be observed from the LF/HF tables that the LF/HF ratio decreased in all five diabetic individuals at the mild hyperglycemic condition compared to the normal condition. This decrease strengthened the study's conclusions by agreeing with previous research that was completed by Jagmeet Singh and his group that HRV is inversely associated with glucose levels.

The column charts also demonstrate that when the glucose level is increased in diabetic individuals, the LF/HF ratio significantly declined simultaneously. This decline was also visible for LF/HF ratios that were calculated by using both the FFT and AR methods for all five non-diabetic individuals.

References

- [1]. http://www.cdc.gov/media/releases/2011/p0126_diabetes.html
- [2]. <http://www.cdc.gov/diabetes/projects/border.htm>
- [3]. <http://borderzine.com/2011/07/diabetes-affects-thousands-in-el-paso-but-the-diabetes-association-is-on-their-side>
- [4]. B. P. Sandler, "How to Prevent Heart Attack," Lee Foundation for Nutritional Research., Milwaukee, WI, 1958.
- [5]. Rajendra Acharya U, Paul Joseph K, Kannathal N, Lim Choo Min and Jasjit Suri S, Heart Rate Variability, Advances in Cardiac Signal Processing, Springer-Verlag Berlin Heidelberg 2007, pp.121-165
- [6]. K. Carr and K. Gingras, "Review of 2005-2006 RERC-AMI National Student Design Competition: Accessible Blood Glucose Monitor Interface," University of Connecticut. CT, Aug. 2006, vol. 1.
- [7]. Makimattila, S, A Schlenzka, M Mantysaari, R Bergholm, P Summanen, P Starr, H Erkkila, H Yki-Jarvinen. Predictors of abnormal cardiovascular autonomic function measured by frequency domain analysis of heart rate variability and conventional tests in patient with type I diabetes. Diabetes care. 2000; 23 (11): 1686-1693.
- [8]. J.P. Singh, M.G. Larson, C.J. O'Donnell, P.F. Wilson, H. Tsuji, D.M. Lloyd-Jones, D. Levy, "Association of hyperglycemia with reduced heart rate variability (The Framingham Heart Study)," The American Journal of Cariology, vol. 86, August 2000
- [9]. http://www.davita-shop.co.ukuploadspicsECG_hart.jpg
- [10]. Task force of the European society of cardiology and the North American society of pacing and electrophysiology. Heart rate variability – standards of measurement, physiological interpretation, and clinical use. Circulation, 93(5):1043–1065, March 1996.
- [11]. http://www.homebusinessandfamilylife.com/images/Autonomic_nervous_system_main_figure.gif
- [12]. <http://www.diabetes.org/living-with-diabetes/treatment-and-care/blood-glucose-control/checking-your-blood-glucose.html>
- [13]. M. B. Gray, R. D. Williams, J. D. Z. Chen. Prototype algorithm for automated determination of gastric slow wave characteristics. Med Biol Eng Comput. 2000 Jan; 38(1): 49-55.
- [14]. O. Pahlm and L. Sörnmo. Software QRS detection in ambulatory monitoring – a review. Med Biol Eng Comput, 22:289–297, July 1984.
- [15]. I. Daskalov and I. Christov. Improvement of resolution in measurement of electrocardiogram RR intervals by interpolation. Med Eng Phys, 19(4):375–379, June 1997.
- [16]. O. Rompelman. Rhythms and analysis techniques. In J. Strackee and N. Westerhof, editors, The Physics of Heart and Circulation, pages 101–120. Institute of Physics Publishing, Bristol, 1993.
- [17]. R.W. DeBoer, J.M. Karemaker, and J. Strackee. Comparing spectra of a series of point events particularly for heart rate variability data. IEEE Trans Biomed Eng, 31(4):384–387, April 1984.
- [18]. J. Mateo and P. Laguna. Improved heart rate variability signal analysis from the beat occurrence times according to the IPFM model. IEEE Trans Biomed Eng, 47(8):985–996, August 2000.
- [19]. C. Rorres, A. Howard. *Application of Linear Algebra 3ed*. 1984 NEW YORK: John Wiley and Sons.

[20]. R.W. DeBoer, J.M. Karemaker, and J. Strackee. Spectrum of a series of point events, generated by the integral pulse frequency modulation model. *Med Biol Eng Comput*, 23:138–142, March 1985.

[21]. M. Lak, N.J. dabanloo, S.K. Setarehdan, “A chaotic model for generating heart rate variability signal using pulse frequency modulation,” in *Computing in Cardiology.*, Belfast, 2010, pp. 857-858.

Glossary

Electrocardiography (ECG): The beat to beat variation of the heart rate.

Hear Rate Variability (HRV): the complex signal that shows the heart's electrical activity.

Appendix A.

Non-Diabetic HRV parameters

Non-diabetic Subject #1

Subject #1	Glucose (mg/dL)	92.00	163.00
Subject #1	Mean RR (ms)	230.90	176.20
Subject #1	STD RR (SDNN) (ms)	367.50	132.50
Subject #1	RMSSD (ms)	491.40	196.30
Subject #1	NN50 (count)	1414.00	994.00
Subject #1	pNN50 (%)	68.20	74.00
Subject #1	VLF Power (FFT)	39.90	4.40
Subject #1	LF Power (FFT)	55.00	24.80
Subject #1	HF Power (FFT)	5.10	70.90
Subject #1	LF/HF (FFT)	10.78	0.35
Subject #1	VLF Power (AR)	41.60	11.00
Subject #1	LF Power (AR)	50.10	28.50
Subject #1	HF Power (AR)	8.30	60.50
Subject #1	LF/HF (AR)	6.05	0.47
Subject #1	LF Power FFT (n.u.)	91.50	25.90
Subject #1	HF Power FFT (n.u.)	8.50	74.10
Subject #1	LF/HF FFT (n.u.)	10.76	0.35
Subject #1	LF Power AR (n.u.)	85.80	32.00
Subject #1	HF Power AR (n.u.)	14.20	68.00
Subject #1	LF/HF AR (n.u.)	6.04	0.47
Subject #1	ApEn	1.15	1.54

Non-Diabetic HRV parameters

Non-diabetic Subject #2

Subject #2	Glucose (mg/dL)	84.00	171.00
Subject #2	Mean RR (ms)	187.00	175.00
Subject #2	STD RR (SDNN) (ms)	361.20	143.30
Subject #2	RMSSD (ms)	509.40	208.00
Subject #2	NN50 (count)	1356.00	1354.00
Subject #2	pNN50 (%)	72.60	72.50
Subject #2	VLF Power (FFT)	80.00	13.70
Subject #2	LF Power (FFT)	15.00	36.90
Subject #2	HF Power (FFT)	5.00	49.40
Subject #2	LF/HF (FFT)	3.04	0.75
Subject #2	VLF Power (AR)	65.60	13.90
Subject #2	LF Power (AR)	32.00	36.90
Subject #2	HF Power (AR)	2.40	49.30
Subject #2	LF/HF (AR)	13.21	0.75
Subject #2	LF Power FFT (n.u.)	75.20	42.80
Subject #2	HF Power FFT (n.u.)	24.80	57.20
Subject #2	LF/HF FFT (n.u.)	3.03	0.75
Subject #2	LF Power AR (n.u.)	93.00	42.80
Subject #2	HF Power AR (n.u.)	7.00	57.20
Subject #2	LF/HF AR (n.u.)	13.29	0.75
Subject #2	ApEn	0.88	1.45

Non-Diabetic HRV parameters

Non-diabetic Subject #3

Subject #3	Glucose (mg/dL)	97.00	165.00
Subject #3	Mean RR (ms)	278.20	235.70
Subject #3	STD RR (SDNN) (ms)	526.50	228.60
Subject #3	RMSSD (ms)	691.40	308.50
Subject #3	NN50 (count)	2647.00	945.00
Subject #3	pNN50 (%)	70.20	74.50
Subject #3	VLF Power (FFT)	17.80	10.70
Subject #3	LF Power (FFT)	75.20	37.60
Subject #3	HF Power (FFT)	7.10	51.70
Subject #3	LF/HF (FFT)	10.64	0.73
Subject #3	VLF Power (AR)	18.20	14.50
Subject #3	LF Power (AR)	71.00	33.60
Subject #3	HF Power (AR)	10.80	51.90
Subject #3	LF/HF (AR)	6.59	0.65
Subject #3	LF Power FFT (n.u.)	91.40	42.10
Subject #3	HF Power FFT (n.u.)	8.60	57.90
Subject #3	LF/HF FFT (n.u.)	10.63	0.73
Subject #3	LF Power AR (n.u.)	86.80	39.30
Subject #3	HF Power AR (n.u.)	13.20	60.70
Subject #3	LF/HF AR (n.u.)	6.58	0.65
Subject #3	ApEn	1.01	1.48

Non-Diabetic HRV parameters

Non-diabetic Subject #4

Subject #4	Glucose (mg/dL)	81.00	158.00
Subject #4	Mean RR (ms)	304.70	176.90
Subject #4	STD RR (SDNN) (ms)	735.90	133.80
Subject #4	RMSSD (ms)	970.60	190.20
Subject #4	NN50 (count)	1762.00	719.00
Subject #4	pNN50 (%)	73.00	73.50
Subject #4	VLF Power (FFT)	52.00	12.50
Subject #4	LF Power (FFT)	46.30	20.30
Subject #4	HF Power (FFT)	1.70	67.20
Subject #4	LF/HF (FFT)	27.02	0.30
Subject #4	VLF Power (AR)	68.60	8.80
Subject #4	LF Power (AR)	30.20	30.30
Subject #4	HF Power (AR)	1.20	60.90
Subject #4	LF/HF (AR)	24.47	0.49
Subject #4	LF Power FFT (n.u.)	96.40	23.20
Subject #4	HF Power FFT (n.u.)	3.60	76.80
Subject #4	LF/HF FFT (n.u.)	26.78	0.30
Subject #4	LF Power AR (n.u.)	96.10	33.20
Subject #4	HF Power AR (n.u.)	3.90	66.80
Subject #4	LF/HF AR (n.u.)	24.64	0.50
Subject #4	ApEn	0.81	1.51

Non-Diabetic HRV parameters

Non-diabetic Subject #5

Subject #5	Glucose (mg/dL)	78.00	148.00
Subject #5	Mean RR (ms)	159.50	246.60
Subject #5	STD RR (SDNN) (ms)	313.00	262.50
Subject #5	RMSSD (ms)	411.90	343.30
Subject #5	NN50 (count)	1677.00	718.00
Subject #5	pNN50 (%)	58.40	68.60
Subject #5	VLF Power (FFT)	37.30	14.10
Subject #5	LF Power (FFT)	47.90	36.10
Subject #5	HF Power (FFT)	14.90	49.70
Subject #5	LF/HF (FFT)	3.22	0.73
Subject #5	VLF Power (AR)	32.60	16.90
Subject #5	LF Power (AR)	49.80	43.70
Subject #5	HF Power (AR)	17.60	39.30
Subject #5	LF/HF (AR)	2.83	1.11
Subject #5	LF Power FFT (n.u.)	76.30	42.10
Subject #5	HF Power FFT (n.u.)	23.70	57.90
Subject #5	LF/HF FFT (n.u.)	3.22	0.73
Subject #5	LF Power AR (n.u.)	73.90	52.60
Subject #5	HF Power AR (n.u.)	26.10	47.40
Subject #5	LF/HF AR (n.u.)	2.83	1.11
Subject #5	ApEn	1.14	1.35

Diabetic HRV parameters

Diabetic Subject #1

Subject #1	Glucose (mg/dL)	73.00	127.00
Subject #1	Mean RR (ms)	188.40	303.10
Subject #1	STD RR (SDNN) (ms)	309.40	575.80
Subject #1	RMSSD (ms)	379.30	756.90
Subject #1	NN50 (count)	3744.00	532.00
Subject #1	pNN50 (%)	67.30	75.90
Subject #1	VLF Power (FFT)	53.00	2.40
Subject #1	LF Power (FFT)	45.40	45.70
Subject #1	HF Power (FFT)	1.60	51.90
Subject #1	LF/HF (FFT)	27.55	0.88
Subject #1	VLF Power (AR)	50.90	13.50
Subject #1	LF Power (AR)	47.30	45.90
Subject #1	HF Power (AR)	1.80	40.60
Subject #1	LF/HF (AR)	26.97	1.13
Subject #1	LF Power FFT (n.u.)	96.50	46.80
Subject #1	HF Power FFT (n.u.)	3.50	53.20
Subject #1	LF/HF FFT (n.u.)	27.57	0.88
Subject #1	LF Power AR (n.u.)	96.40	53.10
Subject #1	HF Power AR (n.u.)	3.60	46.90
Subject #1	LF/HF AR (n.u.)	26.78	1.13
Subject #1	ApEn	1.20	1.01

Diabetic HRV parameters

Diabetic Subject #2

Subject #2	Glucose (mg/dL)	168.00	234.00
Subject #2	Mean RR (ms)	316.60	247.20
Subject #2	STD RR (SDNN) (ms)	622.00	287.30
Subject #2	RMSSD (ms)	837.60	389.10
Subject #2	NN50 (count)	600.00	1731.00
Subject #2	pNN50 (%)	74.20	79.50
Subject #2	VLF Power (FFT)	61.60	24.00
Subject #2	LF Power (FFT)	34.90	25.80
Subject #2	HF Power (FFT)	3.50	50.20
Subject #2	LF/HF (FFT)	9.87	0.51
Subject #2	VLF Power (AR)	43.90	23.40
Subject #2	LF Power (AR)	52.60	36.50
Subject #2	HF Power (AR)	3.50	40.00
Subject #2	LF/HF (AR)	14.82	0.91
Subject #2	LF Power FFT (n.u.)	90.80	33.90
Subject #2	HF Power FFT (n.u.)	9.20	66.10
Subject #2	LF/HF FFT (n.u.)	9.87	0.51
Subject #2	LF Power AR (n.u.)	93.70	47.70
Subject #2	HF Power AR (n.u.)	6.30	52.30
Subject #2	LF/HF AR (n.u.)	14.87	0.91
Subject #2	ApEn	1.02	1.32

Diabetic HRV parameters

Diabetic Subject #3

Subject #3	Glucose (mg/dL)	136.00	222.00
Subject #3	Mean RR (ms)	351.40	244.00
Subject #3	STD RR (SDNN) (ms)	1163.20	421.70
Subject #3	RMSSD (ms)	1443.60	536.10
Subject #3	NN50 (count)	504.00	1763.00
Subject #3	pNN50 (%)	68.60	68.60
Subject #3	VLF Power (FFT)	28.80	18.60
Subject #3	LF Power (FFT)	59.50	37.60
Subject #3	HF Power (FFT)	11.70	43.80
Subject #3	LF/HF (FFT)	5.09	0.86
Subject #3	VLF Power (AR)	42.40	18.00
Subject #3	LF Power (AR)	48.20	41.50
Subject #3	HF Power (AR)	9.50	40.50
Subject #3	LF/HF (AR)	5.08	1.02
Subject #3	LF Power FFT (n.u.)	83.60	58.50
Subject #3	HF Power FFT (n.u.)	16.40	41.50
Subject #3	LF/HF FFT (n.u.)	5.10	1.41
Subject #3	LF Power AR (n.u.)	83.50	56.10
Subject #3	HF Power AR (n.u.)	16.50	43.90
Subject #3	LF/HF AR (n.u.)	5.06	1.28
Subject #3	ApEn	0.55	1.06

Diabetic HRV parameters

Diabetic Subject #4

Subject #4	Glucose (mg/dL)	141.00	217.00
Subject #4	Mean RR (ms)	214.80	174.50
Subject #4	STD RR (SDNN) (ms)	232.70	175.50
Subject #4	RMSSD (ms)	317.70	222.30
Subject #4	NN50 (count)	830.00	1050.00
Subject #4	pNN50 (%)	72.40	66.60
Subject #4	VLF Power (FFT)	18.90	12.30
Subject #4	LF Power (FFT)	40.30	32.60
Subject #4	HF Power (FFT)	40.90	55.10
Subject #4	LF/HF (FFT)	0.99	0.59
Subject #4	VLF Power (AR)	16.60	14.30
Subject #4	LF Power (AR)	41.40	37.70
Subject #4	HF Power (AR)	42.10	48.00
Subject #4	LF/HF (AR)	0.98	0.78
Subject #4	LF Power FFT (n.u.)	49.60	37.10
Subject #4	HF Power FFT (n.u.)	50.40	62.90
Subject #4	LF/HF FFT (n.u.)	0.98	0.59
Subject #4	LF Power AR (n.u.)	49.60	43.90
Subject #4	HF Power AR (n.u.)	50.40	56.10
Subject #4	LF/HF AR (n.u.)	0.98	0.78
Subject #4	ApEn	1.40	1.47

Diabetic HRV parameters

Diabetic Subject #5

Subject #5	Glucose (mg/dL)	146.00	226.00
Subject #5	Mean RR (ms)	203.90	185.30
Subject #5	STD RR (SDNN) (ms)	380.00	167.10
Subject #5	RMSSD (ms)	486.90	214.70
Subject #5	NN50 (count)	3271.00	972.00
Subject #5	pNN50 (%)	63.60	65.30
Subject #5	VLF Power (FFT)	28.30	28.50
Subject #5	LF Power (FFT)	48.20	31.70
Subject #5	HF Power (FFT)	23.50	39.80
Subject #5	LF/HF (FFT)	2.05	0.80
Subject #5	VLF Power (AR)	26.50	18.00
Subject #5	LF Power (AR)	48.50	30.20
Subject #5	HF Power (AR)	25.00	51.80
Subject #5	LF/HF (AR)	1.94	0.59
Subject #5	LF Power FFT (n.u.)	67.20	44.30
Subject #5	HF Power FFT (n.u.)	32.80	55.70
Subject #5	LF/HF FFT (n.u.)	2.05	0.80
Subject #5	LF Power AR (n.u.)	66.00	36.90
Subject #5	HF Power AR (n.u.)	34.00	63.10
Subject #5	LF/HF AR (n.u.)	1.94	0.58
Subject #5	ApEn	1.07	1.48

Appendix B

14 HRV Parameters in Non-diabetic and diabetic subjects at different Glucose Levels

Non Diabetic (N-D) Subjects

Mean RR

			Glucose Level (mg/dL)
N-D Low			
230.90	Average	CV	92.00
187.10	232.08	23.36	84.00
278.20	STDEV		97.00
304.70	54.21		81.00
159.50			78.00

N-D High

176.20	Average	CV	163.00
175.00	200.66	15.30	171.00
228.60	STDEV		165.00
176.90	30.70		158.00
246.60			148.00

STD RR

N-D Low			
367.50	Average		92.00
361.20	460.82	CV	84.00
526.50	STDEV	33.68	97.00
735.90	155.22		81.00
313.00			78.00

N-D High

132.50	Average		163.00
143.30	180.14	CV	171.00
228.60	STDEV	30.31	165.00
133.80	54.60		158.00
262.50			148.00

RMSSD

N-D Low

491.40	Average		Glucose Level (mg/dL)
509.40	614.94	CV	92.00
691.40	STDEV	32.52	84.00
970.60	199.98		97.00
411.90			81.00
			78.00

N-D High

196.30	Average		163.00
208.00	249.26	CV	171.00
308.50	STDEV	25.59	165.00
190.20	63.79		158.00
343.30			148.00

NN50

N-D Low

1414.00	Average		92.00
1356.00	1571.20	CV	84.00
1647.00	STDEV	10.04	97.00
1762.00	157.71		81.00
1677.00			78.00

N-D High

994.00	Average		163.00
1354.00	946.00	CV	171.00
945.00	STDEV	24.67	165.00
719.00	233.36		158.00
718.00			148.00

pNN50

N-D Low

68.20	Average		92.00
72.60	68.48	CV	84.00
70.20	STDEV	7.78	97.00
73.00	5.33		81.00
58.40			78.00

N-D High

74.00	Average		163.00
72.50	72.62	CV	171.00
74.50	STDEV	2.91	165.00
73.50	2.12		158.00
68.60			148.00

VLF FFT

N-D Low		Average		Level (mg/dL)	
39.90	43.20	CV			92.00
43.00	STDEV		9.26		84.00
37.80	4.00				97.00
48.00					81.00
47.30					78.00

N-D High

14.40	Average			163.00
13.70	13.08	CV		171.00
10.70	STDEV		10.35	165.00
12.50	1.35			158.00
14.10				148.00

LF FFT

N-D Low			
55.00	Average		92.00
52.00	51.28	CV	84.00
55.20	STDEV	7.08	97.00
46.30	3.63		81.00
47.90			78.00

N-D High

24.80	Average			163.00
36.90	31.14	CV		171.00
37.60	STDEV	23.03		165.00
20.30	7.17			158.00
36.10				148.00

HF FFT

N-D Low			
5.10	Average		92.00
5.00	5.56	CV	84.00
7.10	STDEV	14.73	97.00
5.70	0.82		81.00
4.90			78.00

N-D High

60.90	Average			163.00
49.40	55.78	CV		171.00
51.70	STDEV	12.70		165.00
67.20	7.08			158.00
49.70				148.00

LF/HF FFT

N-D Low

10.78	Average		Glucose
10.40	9.37	CV	Level (mg/dL)
7.77	STDEV	12.93	92.00
8.12	1.21		84.00
9.78			97.00
			81.00
			78.00

N-D High

0.41	Average		163.00
0.75	0.58	CV	171.00
0.73	STDEV	32.33	165.00
0.30	0.19		158.00
0.73			148.00

VLF AR

N-D Low

41.60	Average		92.00
45.60	53.58	CV	84.00
43.20	STDEV	24.02	97.00
63.60	12.87		81.00
73.90			78.00

N-D High

11.00	Average		163.00
13.90	17.32	CV	171.00
14.50	STDEV	39.01	165.00
30.30	6.76		158.00
16.90			148.00

LF AR

N-D Low

50.10	Average		92.00
49.00	45.42	CV	84.00
48.00	STDEV	16.83	97.00
30.20	7.64		81.00
49.80			78.00

N-D High

28.50	Average		163.00
36.90	34.60	CV	171.00
33.60	STDEV	15.55	165.00
30.30	5.38		158.00
43.70			148.00

HF AR

N-D Low

8.30	Average		Glucose
5.40	7.26	CV	Level (mg/dL)
8.80	STDEV	17.59	92.00
6.20	1.28		84.00
7.60			97.00
			81.00
			78.00

N-D High

60.50	Average		163.00
49.30	52.38	CV	171.00
51.90	STDEV	15.26	165.00
60.90	7.99		158.00
39.30			148.00

LF/HF AR

N-D Low

6.05	Average		92.00
9.07	6.40	CV	84.00
5.45	STDEV	22.55	97.00
4.90	1.44		81.00
6.55			78.00

N-D High

0.47	Average		163.00
0.75	0.70	CV	171.00
0.65	STDEV	33.24	165.00
0.50	0.23		158.00
1.11			148.00

ApEn

N-D Low

1.15	Average		92.00
0.88	1.00	CV	84.00
1.01	STDEV	13.45	97.00
0.81	0.13		81.00
1.14			78.00

N-D High

1.54	Average		163.00
1.45	1.47	CV	171.00
1.48	STDEV	4.41	165.00
1.51	0.06		158.00
1.35			148.00

Diabetic (D) Subjects

Mean RR

D Low

288.40	Average		73.00
316.60	275.02	CV	168.00
351.40	STDEV	20.84	136.00
214.80	57.32		141.00
203.90			146.00

D High

303.10	Average		127.00
247.20	230.82	CV	234.00
244.00	STDEV	20.24	222.00
174.50	46.71		217.00
185.30			226.00

STD RR

D Low

309.40	Average		73.00
322.00	321.46	CV	168.00
363.20	STDEV	15.98	136.00
232.70	51.37		141.00
380.00			146.00

D High

275.80	Average		127.00
287.30	225.48	CV	234.00
221.70	STDEV	21.97	222.00
175.50	49.55		217.00
167.10			226.00

RMSSD**D Low**

379.30	Average		73.00
437.60	413.02	CV	168.00
443.60	STDEV	14.21	136.00
317.70	58.69		141.00
486.90			146.00

D High

356.90	Average		127.00
389.10	303.82	CV	234.00
336.10	STDEV	23.61	222.00
222.30	71.72		217.00
214.70			226.00

NN50**D Low**

744.00	Average		73.00
600.00	669.80	CV	168.00
504.00	STDEV	16.83	136.00
830.00	112.72		141.00
671.00			146.00

D High

1532.00	Average		127.00
1731.00	1409.60	CV	234.00
1763.00	STDEV	23.83	222.00
1050.00	335.85		217.00
972.00			226.00

pNN50**D Low**

67.30	Average		73.00
74.20	69.22	CV	168.00
68.60	STDEV	5.43	136.00
72.40	3.76		141.00
63.60			146.00

D High

75.90	Average		127.00
79.50	71.18	CV	234.00
68.60	STDEV	7.79	222.00
66.60	5.54		217.00
65.30			226.00

VLF FFT**D Low**

38.00	Average		73.00
51.60	37.12	CV	168.00
28.80	STDEV	22.88	136.00
38.90	8.49		141.00
28.30			146.00

D High

22.40	Average		127.00
24.00	21.16	CV	234.00
18.60	STDEV	25.76	222.00
12.30	5.45		217.00
28.50			226.00

LF FFT**D Low**

45.40	Average		73.00
34.90	42.66	CV	168.00
44.50	STDEV	10.86	136.00
40.30	4.63		141.00
48.20			146.00

D High

35.70	Average		127.00
25.80	32.68	CV	234.00
37.60	STDEV	12.36	222.00
32.60	4.04		217.00
31.70			226.00

HF FFT**D Low**

16.60	Average		73.00
13.50	20.24	CV	168.00
26.70	STDEV	23.33	136.00
20.90	4.72		141.00
23.50			146.00

D High

41.90	Average		127.00
50.20	46.16	CV	234.00
43.80	STDEV	12.27	222.00
55.10	5.66		217.00
39.80			226.00

LF/HF FFT**D Low**

2.73	Average		73.00
2.59	2.19	CV	168.00
1.67	STDEV	18.57	136.00
1.90	0.41		141.00
2.05			146.00

D High

0.85	Average		127.00
0.51	0.72	CV	234.00
0.86	STDEV	19.96	222.00
0.59	0.14		217.00
0.80			226.00

VLF AR**D Low**

30.90	Average		73.00
23.90	28.06	CV	168.00
22.40	STDEV	18.36	136.00
36.60	5.15		141.00
26.50			146.00

D High

13.50	Average		127.00
23.40	17.44	CV	234.00
18.00	STDEV	20.11	222.00
14.30	3.51		217.00
18.00			226.00

LF AR**D Low**

47.30	Average		73.00
52.60	47.60	CV	168.00
48.20	STDEV	7.56	136.00
41.40	3.60		141.00
48.50			146.00

D High

45.90	Average		127.00
36.50	39.76	CV	234.00
41.50	STDEV	8.87	222.00
37.70	3.53		217.00
37.20			226.00

Glucose
Level (mg/dL)

HF AR**D Low**

21.80	Average		73.00
23.50	24.38	CV	168.00
29.50	STDEV	11.49	136.00
22.10	2.80		141.00
25.00			146.00

D High

40.60	Average		127.00
40.00	42.78	CV	234.00
40.50	STDEV	7.32	222.00
48.00	3.13		217.00
44.80			226.00

LF/HF AR**D Low**

2.17	Average		73.00
2.24	1.97	CV	168.00
1.63	STDEV	11.11	136.00
1.87	0.22		141.00
1.94			146.00

D High

1.13	Average		127.00
0.91	0.93	CV	234.00
1.02	STDEV	13.62	222.00
0.78	0.13		217.00
0.83			226.00

ApEn**D Low**

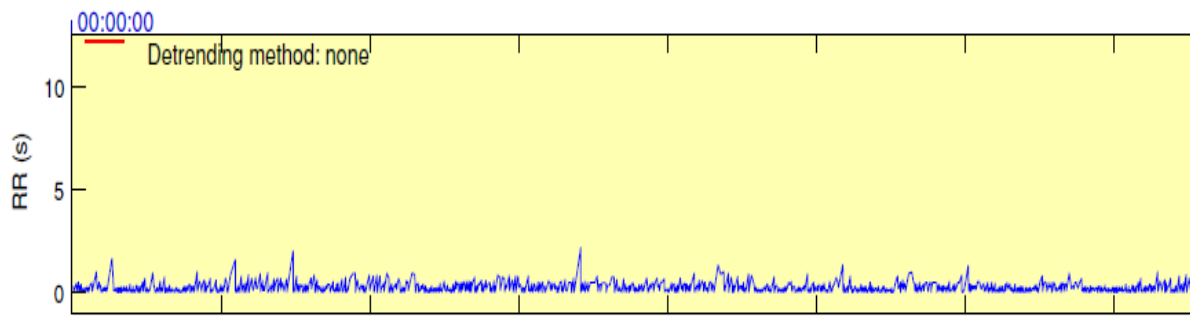
1.20	Average		73.00
1.02	1.16	CV	168.00
1.13	STDEV	11.26	136.00
1.40	0.13		141.00
1.07			146.00

D High

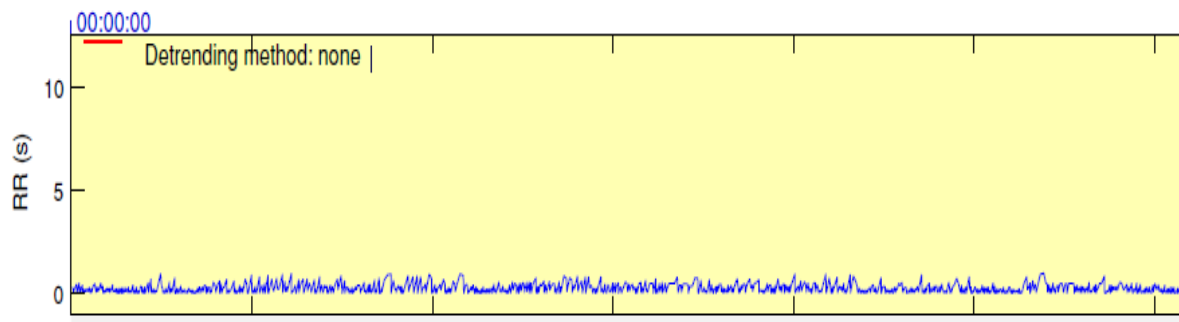
1.01	Average		127.00
1.32	1.27	CV	234.00
1.06	STDEV	15.54	222.00
1.47	0.20		217.00
1.48			226.00

Appendix C.

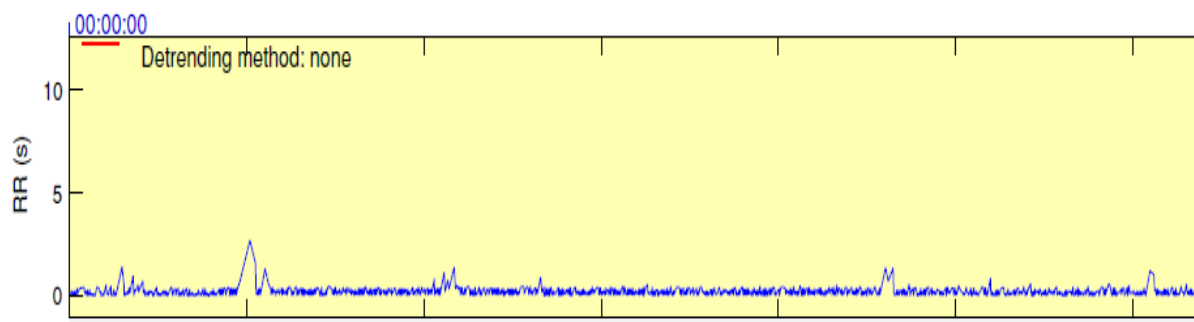
RR intervals time series for non-diabetic and diabetic subjects at different glucose levels



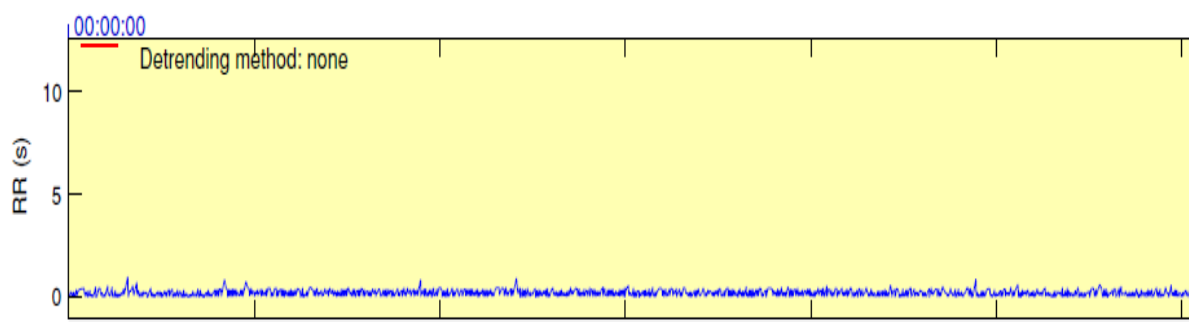
Non-diabetic subject #1 at 92 mg/dL



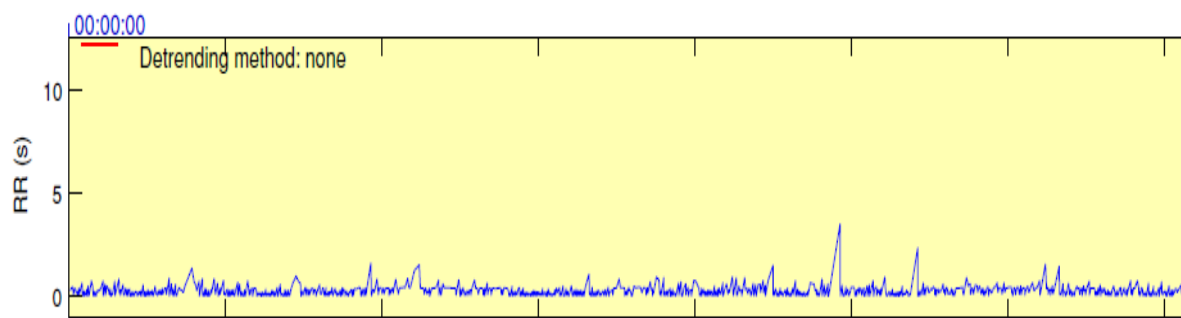
Non-diabetic subject #1 at 163 mg/dL



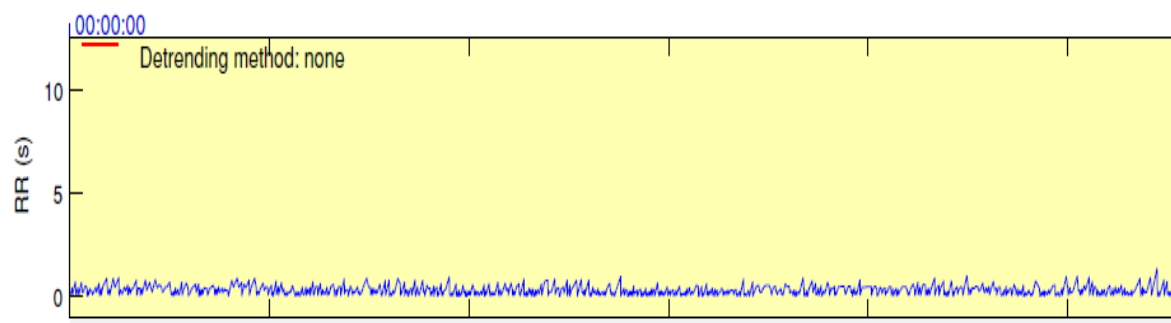
Non-diabetic subject #2 at 84 mg/dL



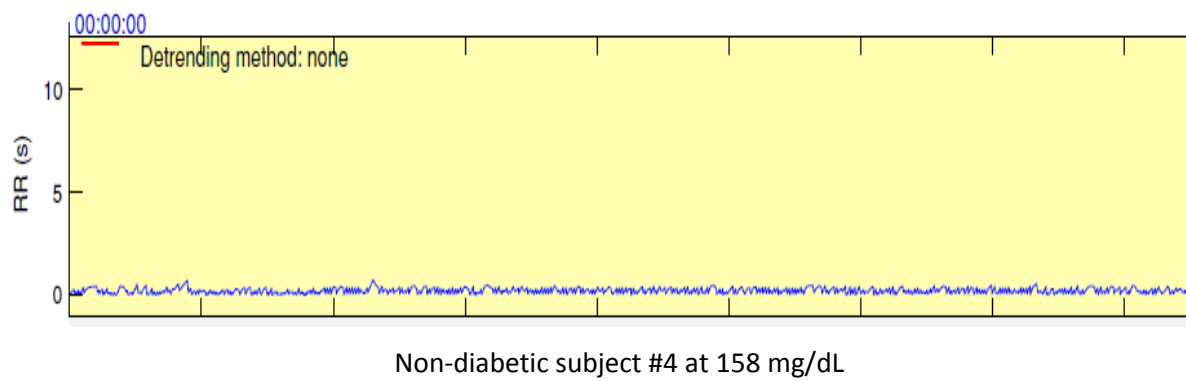
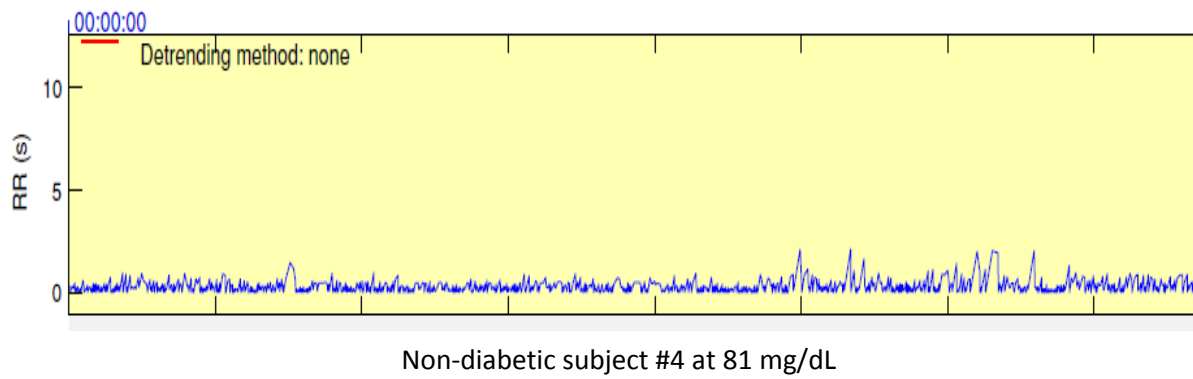
Non-diabetic subject #2 at 171 mg/dL

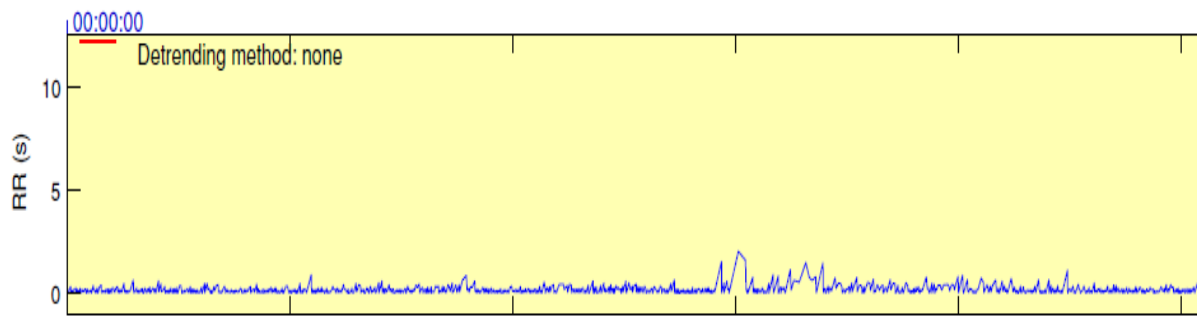


Non-diabetic subject #3 at 97 mg/dL

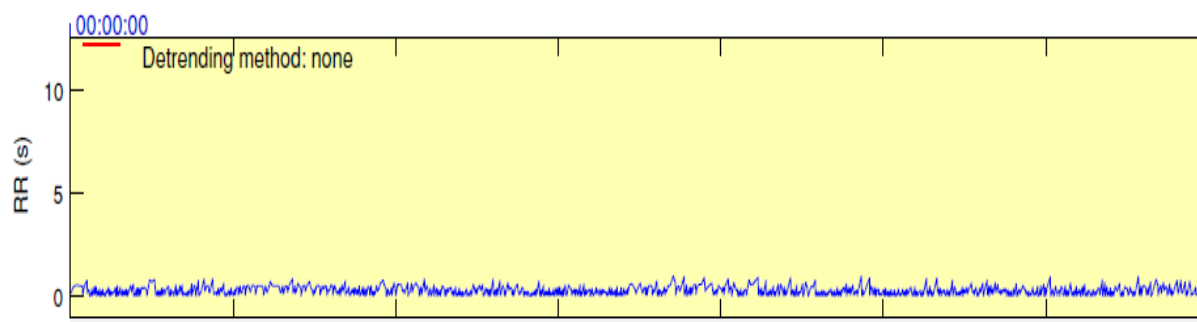


Non-diabetic subject #3 at 165 mg/dL

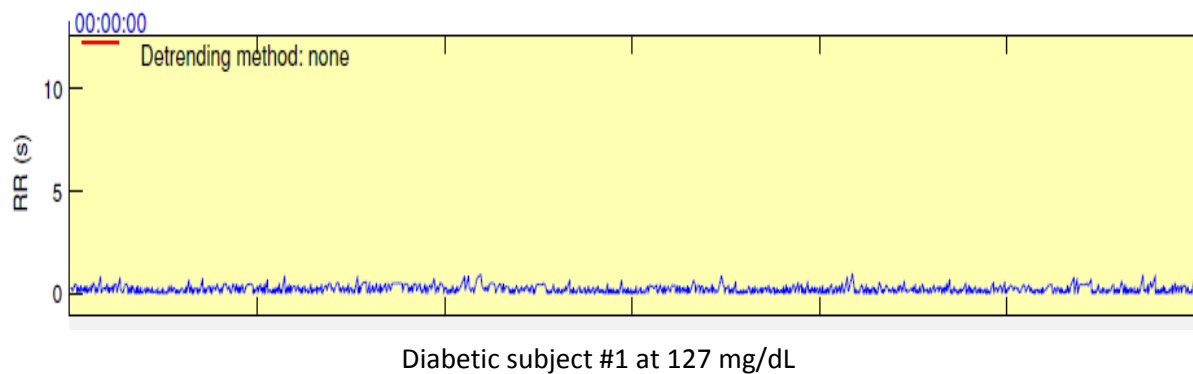
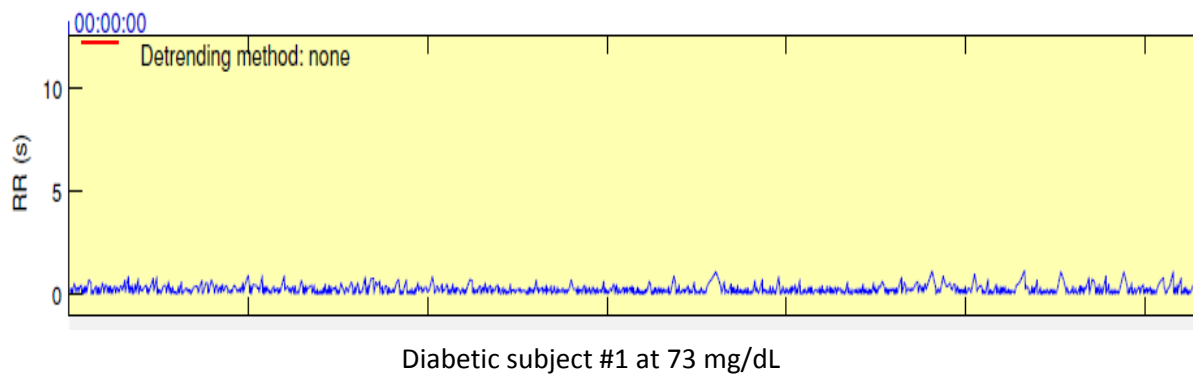


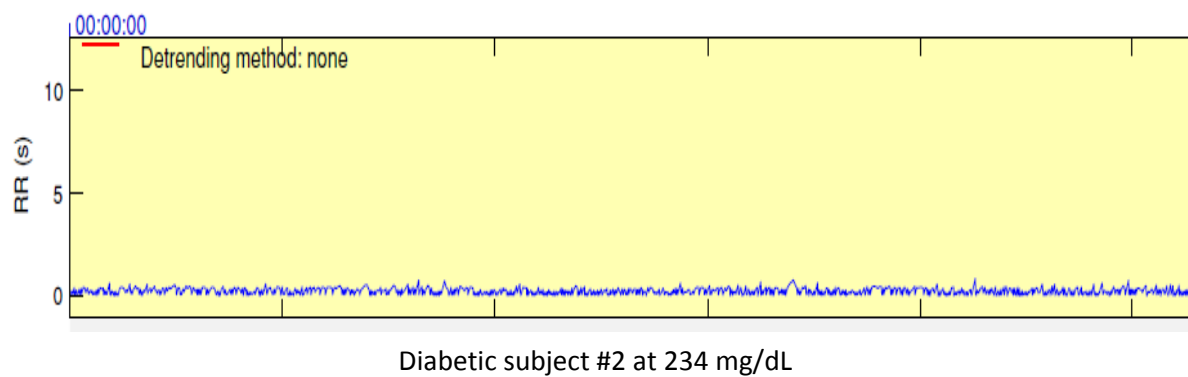
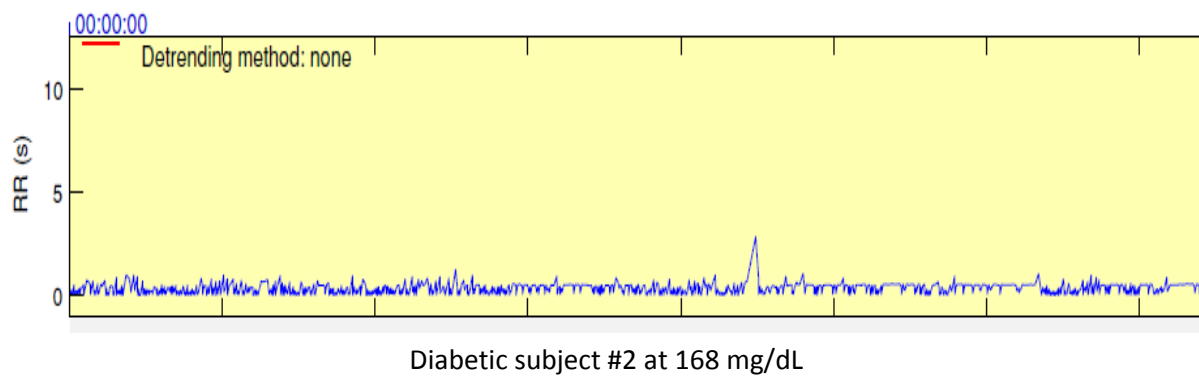


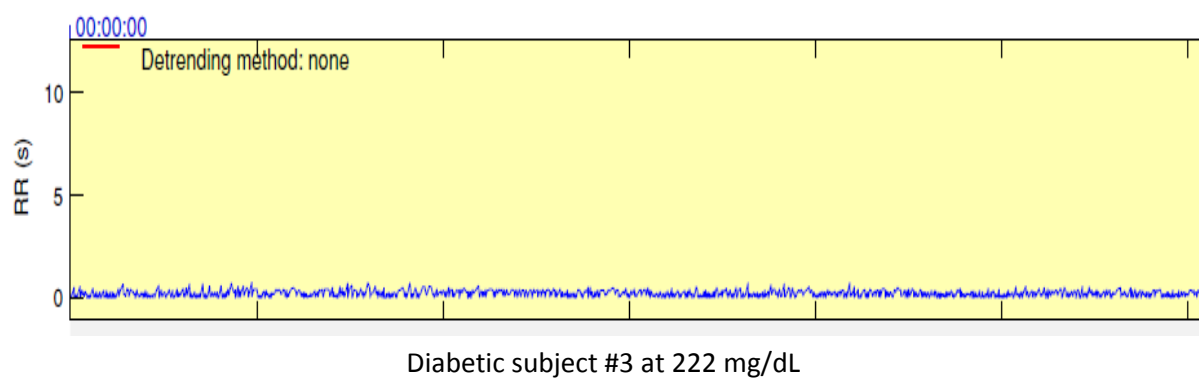
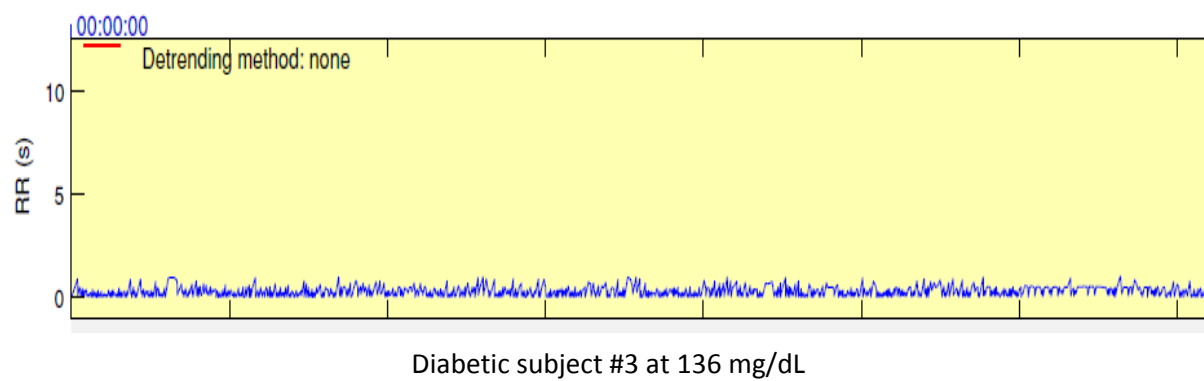
Non-diabetic subject #5 at 78 mg/dL

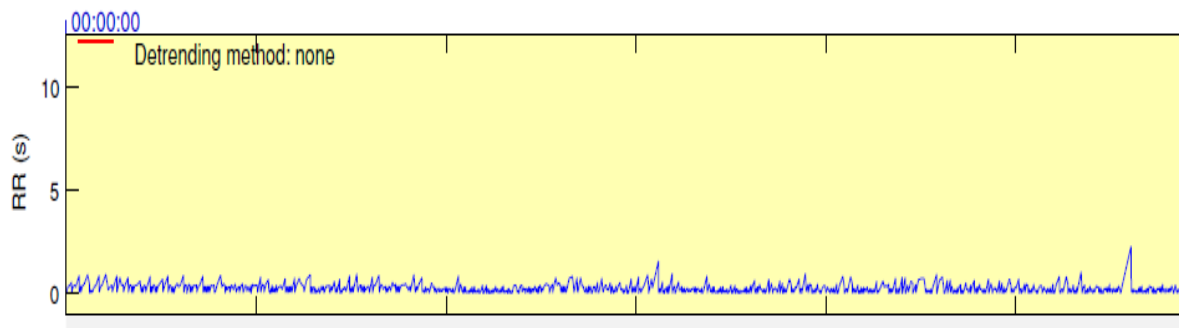


Non-diabetic subject #5 at 148 mg/dL

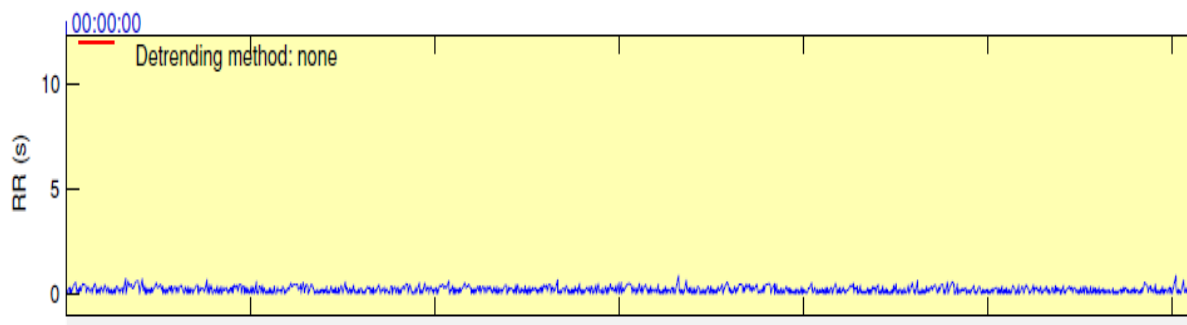




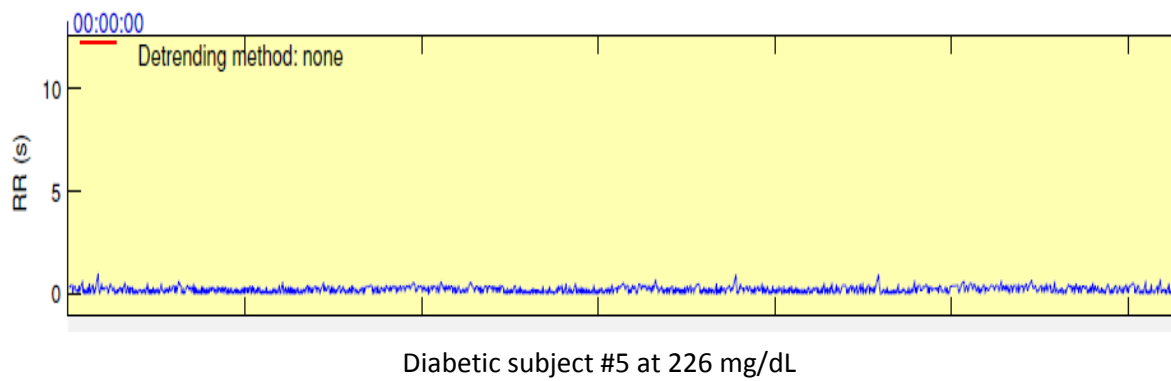
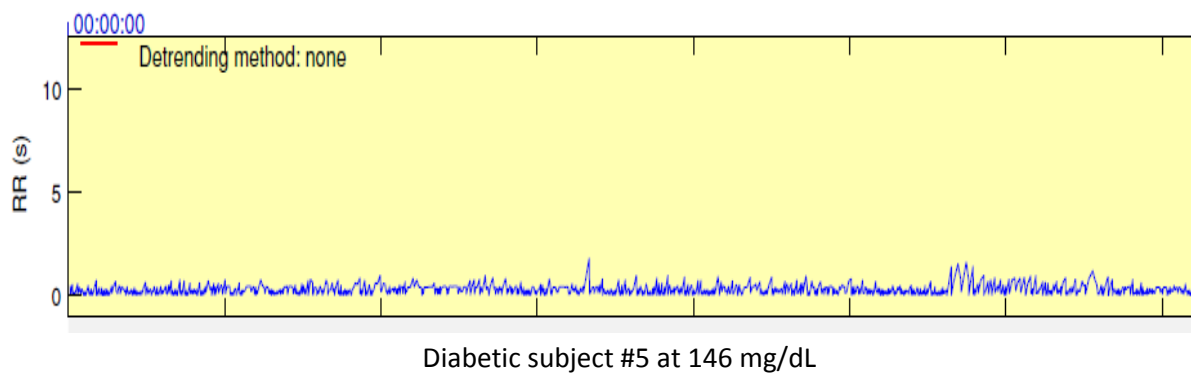




Diabetic subject #4 at 141 mg/dL



Diabetic subject #4 at 217 mg/dL



Appendix D

Raw HRV for Non-diabetic and diabetic subjects at different glucose levels

Non-diabetic Subject #1 at 92 mg/dL glucose level

322	73	84
189	143	221
64	88	165
180	172	331
254	328	193
457	149	86
50	417	905
126	180	110
513	218	46
104	34	157
299	28	174
87	31	144
415	339	58
135	134	25
64	29	68
196	209	270
149	61	71
24	160	40
181	117	61
186	64	391
116	72	498
146	49	44
244	34	187
117	53	42
139	117	298
288	28	147
77	59	129
144	203	136
49	125	349
214	35	88
77	46	367
86	73	353
358	331	69
478	63	155
219	139	80
70	159	88
305	87	357
101	72	82
266	37	98
152	229	456
509	138	193

231	42	150
372	218	66
37	75	69
148	96	38
43	195	38
65	42	110
55	254	63
72	53	120
102	127	59
205	171	76
69	276	64
185	28	41
273	455	139
106	89	28
197	157	64
248	190	537
76	108	263
71	47	45
142	191	63
167	561	137
437	199	206
93	131	53
161	170	325
105	63	414
102	147	730
101	369	497
197	90	267
84	132	136
243	141	80
47	179	390
114	95	35
174	195	70
35	141	193
261	26	166
28	75	40
66	72	82
68	26	35
26	151	256
58	55	304
238	62	28
94	27	28
70	392	29
26	186	813
285	76	175
36	32	321
38	555	38
190	182	68

71	494	34
135	397	41
66	45	39
289	47	55
115	61	59
202	459	25
185	36	126
79	508	74
300	140	57
58	541	206
98	347	320
140	71	171
55	549	167
74	116	59
54	562	181
144	38	40
64	516	217
126	57	36
406	50	93
100	495	142
61	748	117
44	50	63
155	297	183
142	35	58
28	333	68
79	68	401
57	457	167
308	374	74
40	608	281
43	63	30
112	409	97
117	162	71
45	49	203
65	215	283
77	592	38
25	170	164
43	344	294
131	486	55
40	461	133
55	53	37
345	286	28
341	186	108
60	53	101
193	35	35
66	113	98
107	580	71
25	45	130

324	316	512
26	49	68
146	864	361
39	722	63
38	101	31
225	775	122
533	654	50
64	65	50
698	383	31
79	237	38
164	839	261
57	129	40
39	357	104
95	630	62
86	197	84
239	42	140
42	822	63
100	38	222
101	30	212
144	803	192
91	276	84
50	395	130
131	303	57
108	121	40
148	49	299
963	133	159
342	234	65
258	244	101
56	29	73
127	96	32
69	31	38
40	56	53
97	76	76
36	255	41
57	37	93
39	263	26
116	809	178
255	91	85
53	261	76
162	116	100
165	148	46
67	53	315
559	49	301
33	463	91
105	96	178
115	86	49
246	78	81

127	47	24
59	44	191
745	42	55
98	428	42
34	297	25
63	100	69
51	164	71
29	98	185
52	99	119
256	515	88
65	47	86
41	132	68
164	491	84
41	59	147
212	335	107
62	523	85
37	29	114
157	42	169
363	266	75
68	314	53
101	146	50
35	43	35
63	50	232
165	38	28
110	156	84
87	274	101
69	581	64
105	469	29
199	119	90
57	463	30
58	141	82
56	351	43
91	467	75
66	177	56
56	300	66
97	267	447
104	59	819
41	29	213
72	48	238
163	291	511
42	67	31
248	26	92
196	459	630
130	553	189
156	63	459
151	63	226
43	301	53

43	93	202
92	47	946
40	96	984
172	631	525
128	165	441
69	129	77
52	168	430
32	72	77
37	117	70
47	476	52
30	503	68
34	458	276
35	32	38
46	716	504
71	34	136
94	80	272
72	62	77
57	220	94
32	53	44
104	50	329
116	477	390
71	175	88
53	89	468
272	543	514
65	37	324
56	43	100
104	128	78
311	153	479
162	494	457
26	145	33
90	72	496
217	63	502
307	268	497
88	492	458
120	496	29
406	491	330
356	495	132
26	792	402
316	207	94
53	60	192
92	413	288
276	413	136
318	77	66
50	485	343
38	474	46
50	469	340
51	435	169

103	34	272
81	371	50
71	361	164
566	343	204
404	770	309
218	747	60
60	105	549
412	62	70
629	32	166
27	48	110
473	637	58
52	204	59
99	108	72
302	99	106
302	98	177
681	292	183
36	220	363
32	81	92
163	123	422
176	71	46
40	132	246
40	92	216
166	62	487
64	48	477
109	43	852
127	673	66
169	144	51
267	46	49
600	436	36
54	145	77
249	222	41
86	35	79
52	33	99
32	64	64
42	136	46
135	222	127
83	338	117
36	25	132
60	342	120
54	121	407
38	460	59
43	460	29
118	103	398
114	290	111
378	107	325
37	40	192
188	66	336

263	249	177
80	68	344
292	208	178
55	132	538
700	148	534
424	57	340
61	81	195
41	397	187
187	75	335
36	147	446
35	292	80
889	391	88
160	77	303
38	135	192
65	250	100
87	79	487
128	380	219
177	712	67
27	272	71
347	85	34
125	45	212
75	260	203
132	59	131
34	391	517
823	229	41
41	475	30
47	411	66
206	62	46
404	481	265
191	710	49
45	279	54
62	397	63
470	109	446
35	504	90
874	522	59
43	671	54
57	50	42
27	109	87
191	147	85
701	176	62
302	142	111
180	117	134
132	126	59
734	176	167
231	39	75
219	77	48
244	82	266

928	41	71
53	124	44
104	172	38
576	48	300
104	71	206
323	206	70
113	484	60
214	115	85
972	375	314
33	436	75
136	55	115
61	53	56
124	55	79
130	35	112
160	264	27
374	185	56
197	41	410
57	32	92
28	33	486
53	379	306
49	84	187
665	37	430
83	24	177
471	709	134
695	313	107
58	156	251
39	389	154
60	82	60
205	461	79
697	422	174
133	51	35
497	418	99
301	163	57
144	306	415
54	76	77
239	405	108
670	81	61
45	425	69
37	949	77
203	61	50
48	75	192
53	39	234
108	175	46
102	286	229
45	363	68
819	70	114
59	600	296

398	127	36
295	293	28
67	574	142
82	407	77
64	70	282
404	503	60
278	216	38
359	104	44
37	186	293
146	251	92
39	107	47
44	44	69
34	71	36
192	26	55
413	503	31
65	505	48
41	90	44
140	427	40
331	290	55
150	104	72
83	52	62
41	74	260
410	135	36
702	89	239
184	102	139
856	139	53
255	110	59
33	83	74
100	301	63
615	948	199
51	50	36
286	42	104
320	53	107
152	755	275
275	362	145
55	111	52
88	36	98
67	25	41
120	366	37
179	39	114
30	113	121
73	338	215
292	790	226
145	107	155
35	59	116
51	212	334
54	372	163

185	216	391
74	315	108
147	124	102
334	493	231
190	74	38
410	100	47
410	63	78
287	229	25
51	64	47
208	44	56
224	87	534
544	37	817
108	148	53
193	917	534
96	47	518
142	847	328
40	606	78
27	358	93
51	137	486
38	79	253
50	37	246
69	95	477
424	274	36
53	166	145
460	81	76
63	119	504
184	35	370
44	87	134
149	137	273
104	60	68
658	170	139
60	84	191
185	70	129
100	65	139
44	133	303
50	42	177
71	72	456
748	36	27
43	42	477
51	97	386
31	52	82
29	170	447
37	55	384
41	42	87
101	48	949
30	46	470
292	129	205

92	59	290
669	45	330
910	59	185
937	83	490
30	183	485
645	253	259
314	267	238
200	60	494
197	61	692
59	350	113
217	428	101
374	105	83
217	107	184
356	113	245
53	296	59
338	54	43
33	62	108
36	136	299
38	35	60
188	73	111
70	41	88
50	96	43
101	53	250
353	227	205
867	775	252
117	35	29
355	57	27
823	33	110
205	320	33
55	349	26
51	337	125
852	48	101
164	26	25
30	148	340
823	68	53
270	209	85
35	120	62
285	148	217
289	69	198
479	170	245
61	37	108
941	44	143
714	103	168
40	69	88
25	138	233
137	100	178
46	51	207

243	164	273
428	244	28
46	39	263
226	100	329
119	100	120
35	30	38
281	237	160
290	320	62
455	62	278
178	223	151
687	194	46
464	488	133
61	391	67
46	539	40
148	137	74
174	89	213
39	69	137
36	277	369
35	301	97
122	282	206
300	78	94
78	31	46
210	72	82
226	75	117
37	79	71
57	41	182
61	50	64
594	99	229
469	86	34
111	182	117
355	61	47
959	111	170
883	59	120
172	78	161
28	293	111
40	77	64
426	93	146
442	237	27
172	121	165
53	149	268
27	40	164
37	152	80

Non-diabetic subject #1 at 163 mg/dL Glucose level

206	147	87
129	230	56
75	75	114
146	443	173
267	408	130
422	40	38
104	142	99
264	307	167
76	141	327
135	305	70
292	442	353
349	137	63
57	251	27
457	81	44
139	274	84
237	97	293
69	99	43
436	414	160
218	40	84
232	316	63
374	133	58
74	467	339
140	365	78
318	34	188
390	79	154
69	141	78
314	266	288
127	59	66
353	93	77
98	45	288
246	212	64
73	116	79
294	352	141
163	114	302
405	24	45
76	47	191
409	429	61
80	295	73
60	65	350
117	117	44
238	377	157
78	78	137
367	143	241
141	144	68
378	190	301

53	470	106
35	267	27
46	200	303
69	64	46
435	131	69
91	175	243
129	77	73
188	388	34
80	75	64
399	270	459
79	139	128
473	73	233
467	137	67
314	215	73
31	125	342
80	49	310
91	89	146
304	68	372
86	78	92
75	85	135
318	70	214
30	296	34
50	86	79
421	70	302
53	305	56
129	54	84
185	86	302
47	156	77
80	275	76
139	65	225
238	305	137
464	53	58
81	80	31
57	379	409
289	78	28
80	319	246
69	77	93
72	68	77
286	183	301
424	209	52
210	42	218
149	584	166
77	282	121
68	36	208
364	145	80
358	308	66
79	382	84

79	39	211
375	37	50
410	432	73
92	369	67
352	186	90
112	37	56
392	49	108
81	117	173
399	43	73
84	45	277
396	30	79
79	136	78
242	65	155
139	147	65
79	52	41
346	387	68
129	59	142
368	203	63
65	91	64
27	68	466
250	64	89
116	344	137
74	78	65
257	341	124
194	52	80
369	31	132
80	423	155
343	441	147
32	35	284
73	129	132
360	100	132
76	220	158
341	402	130
59	59	297
298	206	63
113	243	69
396	141	136
116	238	178
240	80	132
62	137	460
206	98	391
138	345	56
90	293	116
429	268	237
473	102	63
472	75	27
140	225	242

319	157	106
468	71	77
390	235	298
80	87	136
474	58	260
138	80	277
262	65	170
77	77	131
151	300	70
316	410	90
416	30	159
70	450	76
371	174	65
113	256	257
925	137	73
313	282	73
181	405	76
449	368	200
24	61	69
99	386	79
34	77	52
54	236	265
43	93	111
421	91	54
43	525	231
310	357	70
64	264	77
377	202	72
32	187	66
27	188	405
44	71	130
45	96	230
437	151	65
183	112	29
75	73	125
149	435	105
269	219	26
78	221	35
143	126	56
178	77	78
156	120	361
141	130	76
332	399	54
428	42	150
49	129	259
27	179	142
308	44	203

92	63	45
81	404	80
27	92	186
368	192	270
73	169	37
324	85	379
125	261	77
192	136	314
83	66	69
179	118	104
317	116	370
137	46	112
371	145	40
77	190	100
429	261	98
35	465	55
205	369	65
143	92	86
42	423	288
45	65	452
37	280	129
138	31	79
349	49	236
464	27	31
137	78	94
240	38	395
116	32	38
142	875	43
273	91	35
84	57	141
145	241	156
225	141	149
36	72	51
80	39	86
71	40	99
307	138	137
92	84	79
363	99	472
82	36	255
140	84	222
253	60	215
79	279	49
100	41	39
175	38	79
127	288	68
92	36	585
82	102	180

269	285	114
50	49	255
81	54	91
87	53	110
307	110	359
82	344	67
469	428	332
141	424	81
313	150	50
162	81	146
309	119	147
461	76	77
395	129	236
82	49	177
403	43	174
80	99	44
216	34	108
53	72	67
193	68	61
257	360	225
124	93	51
80	93	77
390	125	140
79	37	269
140	83	331
338	193	83
288	100	261
74	140	137
102	133	141
449	79	55
68	226	41
394	304	184
326	54	430
61	65	215
67	293	87
390	61	123
77	78	133
298	415	207
141	369	89
64	76	335
286	219	69
108	232	80
270	136	83
111	220	57
76	104	288
320	466	30
482	212	419

75	166	156
448	36	220
141	40	70
120	300	314
109	91	57
78	81	89
358	356	266
72	612	51
361	178	502
79	42	79
367	199	206
90	29	116
390	119	39
75	232	77
214	27	360
155	77	50
72	362	39
299	91	376
156	182	54
134	273	26
214	179	376
104	274	72
378	90	225
60	359	33
329	207	192
117	110	368
365	42	76
75	68	383
449	156	79
26	197	456
403	79	381
568	250	80
144	84	207
125	313	37
214	63	102
141	33	81
169	75	137
99	85	296
73	53	341
442	207	44
48	73	39
46	412	433
249	191	433
32	259	440
299	132	365
33	116	100
87	225	310

58	133	153
308	260	143
317	77	256
45	356	78
40	457	395
28	76	50
125	137	310
201	197	69
82	122	78
136	240	465
288	89	129
132	135	240
307	86	68
59	200	205
346	169	226
79	111	75
134	29	271
249	67	33
80	27	512
409	97	316
42	41	42
125	74	75
241	50	384
57	97	32
476	33	361
140	259	76
185	29	88
53	48	368
48	294	370
43	40	82
287	89	436
67	70	69
75	100	286
140	267	116
294	257	139
447	181	256
462	234	101
353	147	367
103	65	62
348	452	76
35	36	147
81	131	331
407	73	267
70	94	116
186	48	411
207	76	107
91	290	406

369	68	72
90	75	143
433	439	259
397	24	62
79	329	157
274	142	164
208	53	55
422	86	77
53	221	289
36	75	35
198	144	106
247	198	280
391	118	154
80	130	439
89	68	140
53	43	290
253	83	371
76	153	67
466	318	458
420	97	87
218	80	263
229	473	44
140	240	545
207	38	57
92	109	412
79	37	347
63	39	139
240	226	340
76	79	71
244	90	72
40	70	
162	227	
147	75	
70	45	
234	72	
323	51	
55	43	
77	95	
329	223	
33	45	
80	127	
427	83	
183	60	
171	207	
73	227	
138	232	
143	292	

168	98
438	66
293	23
65	431
67	453
148	317
217	52
77	78
86	369
363	77
188	273
308	612
285	459
155	220
134	105
227	53
87	38
256	397
47	54
142	400
309	51
145	80
380	267
67	26
430	39
305	41
70	140
66	174
143	142
65	210
162	229
76	366
318	81
50	432
78	332
409	46
461	33
66	67
324	138
67	163
340	441
75	44
92	517
384	136
69	140
329	177
115	186

Non-diabetic subject #2 at 84 mg/dL Glucose level

18	238	305
109	464	53
64	81	80
268	57	379
251	289	78
34	80	319
172	69	77
104	72	68
39	286	183
240	424	209
93	210	42
40	149	584
154	77	282
92	68	36
368	364	145
110	358	308
258	79	382
383	79	39
406	375	37
428	410	432
435	92	369
146	352	186
234	112	37
51	392	49
194	81	117
294	399	43
39	84	45
160	396	30
42	79	136
104	242	65
334	139	147
86	79	52
114	346	387
73	129	59
98	368	203
119	65	91
44	27	68
35	250	64
119	116	344
65	74	78
44	257	341
38	194	52
41	369	31
53	80	423
123	343	441

484	32	35
42	73	129
29	360	100
41	76	220
66	341	402
42	59	59
33	298	206
94	113	243
31	396	141
438	116	238
429	240	80
132	62	137
190	206	98
211	138	345
36	90	293
39	429	268
66	473	102
41	472	75
39	140	225
52	319	157
87	468	71
68	390	235
96	80	87
151	474	58
56	138	80
43	262	65
141	77	77
554	151	300
127	316	410
135	416	30
174	70	450
97	371	174
53	113	256
105	925	137
492	313	282
63	181	405
89	449	368
31	24	61
37	99	386
63	34	77
32	54	236
76	43	93
52	421	91
123	43	525
330	310	357
28	64	264
27	377	202

124	32	187
165	27	188
61	44	71
44	45	96
77	437	151
27	183	112
144	75	73
56	149	435
52	269	219
43	78	221
39	143	126
111	178	77
171	156	120
53	141	130
104	332	399
161	428	42
218	49	129
107	27	179
403	308	44
143	92	63
986	81	404
133	27	92
37	368	192
303	73	169
297	324	85
558	125	261
214	192	136
122	83	66
735	179	118
155	317	116
323	137	46
143	371	145
33	77	190
46	429	261
137	35	465
196	205	369
169	143	92
40	42	423
132	45	65
244	37	280
48	138	31
257	349	49
194	464	27
164	137	78
244	240	38
199	116	32
33	142	875

97	273	91
29	84	57
58	145	241
26	225	141
29	36	72
80	80	39
53	71	40
271	307	138
442	92	84
81	363	99
69	82	36
197	140	84
144	253	60
35	79	279
93	100	41
152	175	38
58	127	288
45	92	36
60	82	102
115	269	285
82	50	49
40	81	54
64	87	53
96	307	110
205	82	344
265	469	428
123	141	424
40	313	150
50	162	81
260	309	119
257	461	76
58	395	129
68	82	49
216	403	43
64	80	99
29	216	34
41	53	72
97	193	68
96	257	360
58	124	93
161	80	93
313	390	125
135	79	37
234	140	83
54	338	193
32	288	100
100	74	140

331	102	133
357	449	79
47	68	226
69	394	304
314	326	54
386	61	65
70	67	293
42	390	61
45	77	78
144	298	415
56	141	369
34	64	76
45	286	219
209	108	232
105	270	136
195	111	220
36	76	104
35	320	466
361	482	212
143	75	166
59	448	36
83	141	40
40	120	300
282	109	91
245	78	81
130	358	356
40	72	612
152	361	178
26	79	42
94	367	199
54	90	29
337	390	119
52	75	232
28	214	27
47	155	77
47	72	362
47	299	91
31	156	182
108	134	273
190	214	179
154	104	274
58	378	90
151	60	359
59	329	207
37	117	110
46	365	42
51	75	68

55	449	156
72	26	197
74	403	79
66	568	250
30	144	84
49	125	313
114	214	63
87	141	33
56	169	75
45	99	85
114	73	53
121	442	207
77	48	73
132	46	412
297	224	191
67	32	259
51	299	132
167	33	116
137	87	225
152	58	133
169	308	260
32	317	77
69	45	356
53	40	457
391	28	76
141	125	137
60	201	197
56	82	122
58	136	240
25	288	89
339	132	135
106	307	86
51	59	200
92	346	169
172	79	111
80	134	29
138	249	67
77	80	27
29	409	97
57	42	41
27	125	74
49	241	50
98	57	97
29	476	33
96	140	259
26	185	29
109	53	48

192	48	294
134	43	40
237	287	89
53	67	70
363	75	100
78	140	267
205	294	257
92	447	181
69	462	234
53	353	147
143	103	65
89	348	452
121	35	36
60	81	131
207	407	73
224	70	94
360	186	48
63	207	76
364	91	290
76	369	68
381	90	75
58	433	439
414	397	24
354	79	329
78	274	142
850	208	53
439	422	86
341	53	221
38	36	75
76	198	144
384	247	198
77	391	118
366	80	130
55	89	68
386	53	43
76	253	83
378	76	153
77	466	318
378	420	97
78	218	80
272	229	473
160	140	240
140	207	38
122	92	109
86	79	37
79	63	39
362	240	226

80	76	79
380	244	90
76	40	70
134	162	227
767	147	75
466	70	45
385	234	72
79	323	51
444	55	43
138	77	95
301	329	223
244	33	45
152	80	127
45	427	83
284	183	60
186	171	207
364	73	227
86	138	232
230	143	292
210	168	98
391	438	66
74	293	23
340	65	431
126	67	453
137	148	317
222	217	52
120	77	78
378	86	369
72	363	77
460	188	273
457	308	612
261	285	459
52	155	220
62	134	105
67	227	53
211	87	38
148	256	397
75	47	54
431	142	400
443	309	51
57	145	80
76	380	267
304	67	26
76	430	39
349	305	41
371	70	140
69	66	174

387	143	142
75	65	210
344	162	229
36	76	366
76	318	81
308	50	432
133	78	332
132	409	46
252	461	33
65	66	67
327	324	138
60	67	163
74	340	441
375	75	44
64	92	517
70	384	136
293	69	140
67	329	177
289	115	186
86	234	150
382	144	139
122	80	277
426	83	170
368	57	131
279	288	70
110	30	90
44	419	159
66	156	76
34	220	65
446	70	257
62	314	73
41	57	73
106	89	76
145	266	200
27	51	69
142	502	79
129	79	52
137	206	265
90	116	111
299	39	54
54	77	231
56	360	70
447	50	77
488	39	72
368	376	66
320	54	405
103	26	130

357	376	230
77	72	65
442	225	29
130	33	125
236	192	105
64	368	26
238	76	35
181	383	56
351	79	78
78	456	361
178	381	76
175	80	54
95	207	150
432	37	259
217	102	142
221	81	203
353	137	45
75	296	80
443	341	186
249	44	270
201	39	37
368	433	379
82	433	77
135	440	314
296	365	69
138	100	104
228	310	370
83	153	112
38	143	40
332	256	100
90	78	98
212	395	55
156	50	65
67	310	86
391	69	288
78	78	452
364	465	129
74	129	79
363	240	236
78	68	31
384	205	94
79	226	395
478	75	38
314	271	43
146	33	35
248	512	141
123	316	156

74	42	149
378	75	51
78	384	86
372	32	99
79	361	137
97	76	79
39	88	472
297	368	255
350	370	222
80	82	215
360	436	49
70	69	39
447	286	79
362	116	68
77	139	585
345	256	180
76	101	114
144	367	255
281	62	91
294	76	110
137	147	359
104	331	67
274	267	332
71	116	81
273	411	50
86	107	146
66	406	147
414	72	77
231	143	236
196	259	177
371	62	174
55	157	44
200	164	108
208	55	67
412	77	61
329	289	225
99	35	51
98	106	77
37	280	140
142	154	269
142	439	331
351	140	83
76	290	261
365	371	137
77	67	141
371	458	55
75	87	41

51	263	184
380	44	430
130	545	215
288	57	87
324	412	123
24	347	133
36	139	207
37	340	89
349	71	335
74	72	69
206	147	87
129	230	56
75	75	114
146	443	173
267	408	130
422	40	38
104	142	99
264	307	167
76	141	327
135	305	70
292	442	353
349	137	63
57	251	27
457	81	44
139	274	84
237	97	293
69	99	43
436	414	160
218	40	84
232	316	63
374	133	58
74	467	339
140	365	78
318	34	188
390	79	154
69	141	78
314	266	288
127	59	66
353	93	77
98	45	288
846	212	64
73	116	79
294	352	141
163	114	302
405	24	45
76	47	191
409	429	61

80	295	73
60	65	350
117	117	44
238	377	157
78	78	137
367	143	241
141	144	68
378	190	301
53	470	106
35	267	27
46	200	303
69	64	46
435	131	69
91	175	243
129	77	73
188	388	34
80	75	64
399	270	459
79	139	128
473	73	233
467	137	67
314	215	73
31	125	342
80	49	310
91	89	146
304	68	372
86	78	92
75	85	135
318	70	214
30	296	34
50	86	79
421	70	302
53	305	56
129	54	84
185	86	302
47	156	77
80	275	76
139	65	225

Non-diabetic subject #2 at 171 mg/dL Glucose level

18	238	305
109	464	53
64	81	80
268	57	379
251	289	78
34	80	319
172	69	77
104	72	68
39	286	183
240	424	209
93	210	42
40	149	584
154	77	282
92	68	36
368	364	145
110	358	308
258	79	382
383	79	39
406	375	37
428	410	432
435	92	369
146	352	186
234	112	37
51	392	49
194	81	117
294	399	43
39	84	45
160	396	30
42	79	136
104	242	65
334	139	147
86	79	52
114	346	387
73	129	59
98	368	203
119	65	91
44	27	68
35	250	64
119	116	344
65	74	78
44	257	341
38	194	52
41	369	31
53	80	423
123	343	441

92	32	35
42	73	129
29	360	100
41	76	220
66	341	402
42	59	59
33	298	206
94	113	243
31	396	141
438	116	238
429	240	80
321	62	137
190	206	98
211	138	345
36	90	293
39	429	268
66	473	102
41	472	75
39	140	225
52	319	157
87	468	71
68	390	235
96	80	87
151	474	58
56	138	80
43	262	65
141	77	77
554	151	300
127	316	410
135	416	30
174	70	450
97	371	174
53	113	256
285	925	137
492	313	282
63	181	405
89	449	368
31	24	61
37	99	386
63	34	77
32	54	236
76	43	93
52	421	91
123	43	525
330	310	357
28	64	264
27	377	202

124	32	187
165	27	188
61	44	71
44	45	96
77	437	151
27	183	112
144	75	73
56	149	435
52	269	219
43	78	221
39	143	126
111	178	77
171	156	120
53	141	130
104	332	399
161	428	42
218	49	129
107	27	179
403	308	44
143	92	63
986	81	404
133	27	92
37	368	192
303	73	169
297	324	85
558	125	261
214	192	136
435	83	66
735	179	118
155	317	116
323	137	46
143	371	145
33	77	190
46	429	261
137	35	465
196	205	369
169	143	92
40	42	423
132	45	65
244	37	280
48	138	31
257	349	49
194	464	27
164	137	78
244	240	38
199	116	32
33	142	875

97	273	91
29	84	57
58	145	241
26	225	141
29	36	72
156	80	39
53	71	40
271	307	138
442	92	84
81	363	99
69	82	36
197	140	84
144	253	60
35	79	279
93	100	41
152	175	38
58	127	288
45	92	36
60	82	102
115	269	285
82	50	49
40	81	54
64	87	53
96	307	110
205	82	344
265	469	428
123	141	424
40	313	150
50	162	81
260	309	119
257	461	76
58	395	129
68	82	49
216	403	43
64	80	99
29	216	34
41	53	72
97	193	68
96	257	360
58	124	93
161	80	93
313	390	125
456	79	37
234	140	83
54	338	193
32	288	100
100	74	140

331	102	133
357	449	79
47	68	226
69	394	304
314	326	54
386	61	65
70	67	293
42	390	61
45	77	78
144	298	415
56	141	369
34	64	76
45	286	219
209	108	232
105	270	136
195	111	220
36	76	104
35	320	466
361	482	212
143	75	166
59	448	36
83	141	40
40	120	300
282	109	91
374	78	81
130	358	356
40	72	612
152	361	178
26	79	42
94	367	199
54	90	29
337	390	119
52	75	232
28	214	27
47	155	77
47	72	362
47	299	91
31	156	182
108	134	273
190	214	179
154	104	274
58	378	90
151	60	359
59	329	207
37	117	110
46	365	42
51	75	68

55	449	156
72	26	197
74	403	79
66	568	250
30	144	84
49	125	313
114	214	63
87	141	33
56	169	75
45	99	85
114	73	53
121	442	207
77	48	73
132	46	412
297	249	191
67	32	259
51	299	132
167	33	116
137	87	225
152	58	133
169	308	260
32	317	77
69	45	356
53	40	457
391	28	76
141	125	137
60	201	197
56	82	122
58	136	240
25	288	89
339	132	135
106	307	86
51	59	200
92	346	169
172	79	111
80	134	29
138	249	67
77	80	27
29	409	97
57	42	41
27	125	74
49	241	50
98	57	97
29	476	33
96	140	259
26	185	29
109	53	48

192	48	294
134	43	40
237	287	89
53	67	70
363	75	100
78	140	267
205	294	257
92	447	181
69	462	234
53	353	147
143	103	65
89	348	452
121	35	36
60	81	131
207	407	73
224	70	94
360	186	48
63	207	76
364	91	290
76	369	68
381	90	75
58	433	439
414	397	24
354	79	329
78	274	142
265	208	53
439	422	86
341	53	221
38	36	75
76	198	144
384	247	198
77	391	118
366	80	130
55	89	68
386	53	43
76	253	83
378	76	153
77	466	318
378	420	97
78	218	80
272	229	473
160	140	240
140	207	38
122	92	109
86	79	37
79	63	39
362	240	226

80	76	79
380	244	90
76	40	70
134	162	227
767	147	75
466	70	45
385	234	72
79	323	51
444	55	43
138	77	95
301	329	223
244	33	45
152	80	127
45	427	83
284	183	60
186	171	207
364	73	227
86	138	232
230	143	292
210	168	98
391	438	66
74	293	23
340	65	431
126	67	453
137	148	317
222	217	52
120	77	78
378	86	369
72	363	77
460	188	273
457	308	612
261	285	459
52	155	220
62	134	105
67	227	53
211	87	38
148	256	397
75	47	54
431	142	400
443	309	51
57	145	80
76	380	267
304	67	26
76	430	39
349	305	41
371	70	140
69	66	174

387	143	142
75	65	210
344	162	229
36	76	366
76	318	81
308	50	432
133	78	332
132	409	46
252	461	33
65	66	67
327	324	138
60	67	163
74	340	441
375	75	44
64	92	517
70	384	136
293	69	140
67	329	177
289	115	186
86	234	150
382	144	139
122	80	277
426	83	170
368	57	131
279	288	70
110	30	90
44	419	159
66	156	76
34	220	65
446	70	257
62	314	73
41	57	73
106	89	76
145	266	200
27	51	69
142	502	79
129	79	52
137	206	265
90	116	111
299	39	54
54	77	231
56	360	70
447	50	77
488	39	72
368	376	66
320	54	405
103	26	130

357	376	230
77	72	65
442	225	29
130	33	125
236	192	105
64	368	26
238	76	35
181	383	56
351	79	78
78	456	361
178	381	76
175	80	54
95	207	150
432	37	259
217	102	142
221	81	203
353	137	45
75	296	80
443	341	186
249	44	270
201	39	37
368	433	379
82	433	77
135	440	314
296	365	69
138	100	104
228	310	370
83	153	112
38	143	40
332	256	100
90	78	98
212	395	55
156	50	65
67	310	86
391	69	288
78	78	452
364	465	129
74	129	79
363	240	236
78	68	31
384	205	94
79	226	395
478	75	38
314	271	43
146	33	35
248	512	141
123	316	156

74	42	149
378	75	51
78	384	86
372	32	99
79	361	137
97	76	79
39	88	472
297	368	255
350	370	222
80	82	215
360	436	49
70	69	39
447	286	79
362	116	68
77	139	585
345	256	180
76	101	114
144	367	255
281	62	91
294	76	110
137	147	359
104	331	67
274	267	332
71	116	81
273	411	50
86	107	146
66	406	147
414	72	77
231	143	236
196	259	177
371	62	174
55	157	44
200	164	108
208	55	67
412	77	61
329	289	225
99	35	51
98	106	77
37	280	140
142	154	269
142	439	331
351	140	83
76	290	261
365	371	137
77	67	141
371	458	55
75	87	41

51	263	184
380	44	430
130	545	215
288	57	87
324	412	123
24	347	133
36	139	207
37	340	89
349	71	335
74	72	69
206	147	87
129	230	56
75	75	114
146	443	173
267	408	130
422	40	38
104	142	99
264	307	167
76	141	327
135	305	70
292	442	353
349	137	63
57	251	27
457	81	44
139	274	84
237	97	293
69	99	43
436	414	160
218	40	84
232	316	63
374	133	58
74	467	339
140	365	78
318	34	188
390	79	154
69	141	78
314	266	288
127	59	66
353	93	77
98	45	288
846	212	64
73	116	79
294	352	141
163	114	302
405	24	45
76	47	191
409	429	61

80	295	73
60	65	350
117	117	44
238	377	157
78	78	137
367	143	241
141	144	68
378	190	301
53	470	106
35	267	27
46	200	303
69	64	46
435	131	69
91	175	243
129	77	73
188	388	34
80	75	64
399	270	459
79	139	128
473	73	233
467	137	67
314	215	73
31	125	342
80	49	310
91	89	146
304	68	372
86	78	92
75	85	135
318	70	214
30	296	34
50	86	79
421	70	302
53	305	56
129	54	84
185	86	302
47	156	77
80	275	76

Non-diabetic subject #3 at 97 mg/dL Glucose level

301	33	40
434	326	34
447	77	137
78	114	93
364	91	104
388	425	265
158	228	62
173	192	47
215	62	675
97	183	625
410	168	601
96	74	324
244	74	334
651	270	88
122	229	304
76	96	67
237	83	44
28	76	161
249	317	53
32	319	67
179	75	161
59	392	36
80	794	47
65	404	851
325	402	113
39	290	42
512	114	550
33	398	169
144	403	26
48	407	280
768	340	121
464	78	605
146	393	43
30	26	29
37	189	57
244	657	36
44	85	31
94	337	183
187	415	3526
184	338	42
49	75	543
26	402	152
30	391	85
225	388	43
299	388	152

233	401	33
330	409	73
365	421	65
758	341	89
49	92	52
609	324	45
67	99	463
511	431	88
377	420	142
221	413	353
111	369	197
362	273	46
50	41	68
32	52	133
37	99	53
66	172	179
35	70	444
162	25	442
53	102	438
67	56	258
87	499	42
122	34	90
729	120	42
42	52	72
126	195	306
280	105	42
853	188	290
148	114	433
313	32	139
56	255	392
259	92	305
568	191	70
139	113	59
59	77	230
130	369	417
58	425	43
399	56	33
250	198	55
62	121	67
337	29	59
39	36	30
307	265	193
345	52	506
45	389	146
116	54	44
28	78	554
41	61	39

173	167	55
94	48	27
76	120	56
26	26	222
241	70	770
42	187	143
124	31	30
170	69	34
56	143	426
144	209	454
48	84	79
63	56	39
37	155	331
196	43	216
237	51	278
189	85	54
201	69	387
50	70	58
110	103	297
48	154	941
191	71	297
83	149	136
215	35	67
138	56	24
274	139	51
46	26	90
36	197	32
124	209	34
35	58	50
554	284	41
171	30	65
48	55	71
238	66	131
74	66	243
29	238	193
203	216	114
34	41	67
204	73	31
34	208	181
56	36	68
46	201	62
83	217	347
339	80	64
86	200	65
133	95	156
37	110	87
238	107	39

52	40	117
199	161	81
81	122	73
228	55	26
284	74	148
55	384	116
174	39	160
199	63	35
37	56	193
501	168	82
198	154	47
119	146	46
118	198	135
164	48	215
125	49	102
28	79	32
284	152	50
132	25	31
113	196	96
295	43	228
212	26	57
86	368	57
385	201	69
109	60	96
160	94	497
149	83	32
411	81	72
408	169	138
101	150	149
898	110	102
51	75	69
61	27	117
629	51	173
128	73	100
361	127	117
51	56	294
128	40	191
49	37	223
596	47	58
41	72	45
120	94	39
38	140	35
117	315	80
68	73	27
47	82	79
272	418	93
431	190	105

338	307	123
315	431	68
278	40	2357
222	53	41
200	184	31
513	73	70
33	82	144
373	45	210
25	169	44
37	508	280
289	40	192
745	125	61
50	43	118
33	48	655
118	60	96
862	69	378
65	28	71
76	50	450
48	48	456
32	384	187
42	153	186
188	70	216
54	55	385
383	257	319
24	86	480
347	77	359
131	75	75
41	109	371
42	35	49
164	107	340
27	166	356
289	530	156
31	221	277
81	55	256
86	125	271
64	30	606
45	37	208
65	283	343
77	245	79
337	47	439
162	55	332
858	77	122
294	347	190
108	83	125
635	62	134
196	29	153
78	55	130

29	284	376
79	78	216
398	61	60
112	249	306
300	41	55
778	69	108
114	95	110
154	54	84
113	288	36
153	72	69
55	248	405
268	28	407
356	145	413
46	78	419
95	98	428
193	234	441
28	44	136
297	86	131
77	35	70
32	50	934
94	109	531
45	137	624
280	91	112
74	187	132
304	92	418
113	50	323
326	31	111
53	451	554
29	83	522
39	30	228
120	144	516
57	172	343
65	51	147
248	198	207
692	42	411
39	40	81
597	177	279
159	136	95
51	29	46
239	27	271
50	48	143
47	255	445
189	117	437
45	79	37
53	281	324
55	286	325
150	97	178

78	47	199
57	151	236
42	59	440
34	65	441
41	126	667
320	84	212
42	55	429
76	166	430
51	199	307
27	266	131
763	53	655
312	80	201
74	62	417
306	189	415
87	332	441
388	49	441
384	190	444
34	38	149
407	183	242
405	463	37
326	119	427
117	68	337
34	35	93
82	240	440
50	255	439
42	275	238
190	333	104
117	78	509
149	409	86
63	404	360
158	408	435
154	849	370
80	426	77
146	432	343
35	433	517
58	398	248
56	37	198
67	203	443
28	233	674
214	74	328
95	283	285
51	75	432
178	446	429
122	268	773
58	289	80
98	192	215
39	44	1570

88	157	362
101	107	442
350	34	105
48	72	331
161	512	354
36	427	81
71	426	523
41	450	186
88	438	139
58	434	417
150	233	1458
72	194	119
99	430	93
55	431	167
171	357	165
106	76	74
31	434	627
50	156	46
35	715	236
129	311	272
100	375	174
64	44	27
38	188	85
280	149	156
96	940	92
73	792	640
275	200	246
207	95	92
87	276	301
29	37	252
43	907	29
190	45	61
163	232	191
46	179	62
91	109	40
432	54	143
170	40	161
30	207	192
53	288	81
25	35	39
63	213	296
68	247	488
590	386	343
157	42	423
40	26	114
69	241	288
37	99	404

135	50	37
151	47	516
111	352	257
52	56	331
74	163	74
48	186	406
35	148	739
72	102	71
111	45	410
51	126	399
64	134	396
28	29	390
327	64	201
54	194	58
51	648	144
31	60	242
264	712	88
142	90	76
35	59	402
46	59	77
61	33	552
43	178	156
40	35	41
38	399	415
314	618	234
63	74	170
62	305	396
154	449	216
50	41	73
98	66	109
33	234	166
62	300	90
88	310	129
42	36	307
44	786	69
122	738	44
32	508	227
45	408	177
68	80	63
247	190	103
150	77	122
149	112	182
56	34	36
305	402	306
448	43	502
57	166	280
369	346	140

263	138	32
83	210	30
76	24	186
334	251	133
78	195	51
146	56	285
264	129	63
408	36	76
320	306	122
100	62	79
351	45	380
302	44	423
173	108	92
35	298	145
64	121	39
176	56	49
322	207	76
572	249	176
138	127	424
170	50	201
168	27	174
118	47	91
412	146	75
332	59	348
70	521	88
218	31	45
36	25	334
422	23	774
62	262	123
131	170	342
123	47	74
120	75	413
42	62	417
203	368	762
226	32	412
47	389	90
218	151	141
126	227	229
156	121	43
425	675	435
110	29	342
151	53	77
46	53	36
56	69	82
263	329	61
382	628	152
152	278	173

236	131	60
99	320	156
153	211	41
35	961	171
75	222	131
44	41	33
130	68	81
100	916	636
192	52	42
66	218	104
307	63	200
180	516	106
31	270	93
84	269	30
426	304	47
64	48	106
358	908	185
237	323	62
218	405	30
36	204	71
124	142	36
264	402	488
156	288	59
84	144	162
83	40	156
55	63	189
116	60	133
143	643	93
32	172	34
95	43	65
238	576	137
182	143	260
340	30	424
222	114	55
26	557	27
338	597	74
37	184	723
79	779	134
378	172	111
366	537	80
360	42	208
419	101	151
455	776	251
332	1509	245
61	56	100
48	235	50
35	64	208

269	63	63
62	386	33
377	249	30
260	112	46
51	40	147
420	47	511
58	42	104
161	188	71
189	50	116
47	118	25
56	151	48
330	28	156
294	31	321
206	65	28
848	32	83
333	396	301
95	105	81
432	202	188
429	196	202
278	61	376
144	74	335
419	53	202
143	53	277
266	69	407
413	26	554
410	45	159
408	92	640
66	134	240
344	235	30
137	315	229
277	148	215
415	34	436
152	59	44
826	40	220
407	408	328
292	69	219
122	153	65
420	208	41
434	62	42
436	27	364
438	90	428
434	59	164
873	80	169
429	122	80
424	137	181
261	26	27
153	190	258

412	404	362
414	82	55
416	762	120
297	64	51
118	64	208
420	39	225
272	30	356
147	111	152
259	348	639
170	151	106
395	40	185
24	32	139
70	273	40
80	175	37
267	55	1075
414	54	5766
412	222	58
416	38	238
450	72	833
799	136	877
76	144	25
443	45	187
177	139	278
58	38	67
615	27	74
420	49	124
424	65	152
425	47	289
421	201	172
430	83	85
418	178	394
419	52	241
412	26	157
411	51	403
338	39	408
75	88	415
814	53	424
370	60	168

Non-diabetic subject #3 at 165 mg/dL Glucose level

112	87	343
430	119	500
46	710	71
738	137	209
138	72	86
71	44	117
435	359	484
149	136	483
37	62	511
694	118	496
224	223	209
218	660	112
530	306	165
414	421	500
36	72	505
264	651	203
64	340	303
388	66	24
250	59	61
258	266	441
94	86	129
153	84	160
205	471	220
461	616	92
212	103	809
633	186	78
67	41	454
383	63	454
71	853	469
514	58	479
874	39	473
230	149	473
120	105	67
365	84	414
69	240	505
873	32	365
448	40	47
928	40	93
81	81	123
54	44	68
333	402	455
199	135	371
135	349	138
137	26	369
462	153	408

282	372	74
554	34	247
71	158	207
444	26	457
133	72	476
311	322	78
436	41	383
803	122	53
69	327	121
421	225	42
416	117	250
65	619	400
377	78	82
117	727	51
815	804	339
308	40	71
694	140	151
412	198	306
227	257	463
826	227	470
424	856	480
567	113	338
491	365	148
252	434	80
226	180	208
462	36	87
466	57	392
697	92	601
244	27	344
171	404	73
62	457	67
56	156	699
59	806	96
151	46	458
222	57	94
46	553	65
424	36	592
90	342	560
178	480	72
342	783	354
126	217	100
93	29	382
92	107	75
696	826	90
72	216	371
370	229	916
652	93	63

453	329	397
44	41	538
75	220	67
62	801	409
119	125	745
141	153	109
326	35	86
465	39	73
607	196	244
217	35	77
619	454	69
35	159	101
347	308	36
58	148	236
77	189	95
332	108	49
95	378	770
434	78	274
385	225	49
383	77	234
71	129	39
88	57	345
371	141	478
459	164	126
536	238	354
318	114	477
72	131	405
383	76	68
95	269	1014
473	65	372
183	84	93
300	417	379
400	635	121
168	240	441
381	102	380
280	211	491
312	85	480
263	52	257
71	192	303
89	156	653
33	126	276
784	52	187
458	32	436
898	147	201
444	408	499
691	971	95
37	28	266

587	192	732
432	164	338
799	415	404
80	73	74
436	147	463
900	334	455
396	273	85
71	46	97
223	62	53
259	29	42
92	165	67
392	69	57
658	36	79
306	274	124
486	90	303
406	243	39
71	87	493
284	31	79
558	528	302
72	42	188
88	220	402
228	210	343
32	313	78
751	108	65
103	30	586
476	71	375
73	75	93
692	341	381
236	354	53
387	52	48
91	25	65
72	92	298
171	60	119
110	189	256
68	33	72
202	193	561
74	70	30
60	118	81
139	408	66
168	63	29
244	192	60
188	36	209
527	125	62
340	152	117
168	60	66
115	233	164
64	54	143

35	62	313
45	88	190
84	385	123
243	40	112
76	50	110
59	364	27
55	248	41
151	37	158
215	74	89
38	673	83
59	226	758
43	40	565
55	79	396
110	231	88
45	65	45
475	296	35
147	89	69
125	217	189
90	106	67
98	64	76
461	58	245
79	190	76
346	67	85
142	219	295
433	470	26
57	109	223
737	68	152
106	192	182
70	299	91
465	42	138
470	211	332
55	277	144
633	310	293
192	66	525
68	41	536
338	57	74
140	175	161
141	72	45
198	284	53
126	68	82
469	83	174
91	269	202
63	487	117
259	163	59
104	47	55
488	131	75
592	71	51

257	145	66
87	50	33
33	121	106
56	146	396
349	104	70
67	153	977
466	87	412
486	200	79
44	43	423
857	374	138
138	53	229
322	186	205
333	425	293
236	136	984
35	106	278
508	76	320
357	261	71
139	183	124
76	140	350
266	257	87
188	563	521
293	481	312
484	28	944
150	60	79
259	32	750
71	26	67
169	26	495
147	191	378
144	492	89
455	36	37
900	52	283
456	37	197
465	184	46
70	48	162
401	111	158
87	118	56
385	638	89
169	98	341
307	83	53
135	233	162
225	82	332
607	60	144
253	291	68
75	141	104
74	409	89
47	126	57
39	79	32

57	41	382
780	96	542
55	368	135
132	36	88
805	187	104
32	311	80
32	59	382
41	43	94
182	67	67
91	129	471
74	153	152
142	213	157
39	404	408
307	334	149
170	55	565
156	240	203
886	82	66
626	181	137
77	263	421
72	148	71
185	81	148
707	334	104
47	136	236
356	194	214
150	315	58
285	305	78
42	288	54
120	94	175
31	314	136
328	340	131
407	68	70
81	127	311
814	42	43
68	101	37
30	45	168
59	59	206
471	156	269
136	254	480
163	60	877
84	44	132
108	31	32
783	856	457
225	75	59
268	122	351
43	52	183
549	41	223
385	78	219

392	135	931
83	57	258
41	56	73
216	86	1379
95	39	93
520	45	25
29	107	114
364	296	200
438	171	39
24	30	107
175	86	44
63	65	257
59	719	819
638	51	57
143	35	736
65	142	114
222	245	143
61	514	228
301	536	42
340	248	43
953	206	237
79	210	62
123	368	55
40	524	68
80	537	360
63	546	289
43	370	293
184	163	42
137	77	27
70	423	26
50	517	74
209	198	93
629	202	367
39	109	64
200	222	219
29	296	62
27	385	340
67	128	29
29	141	88
303	145	38
37	65	246
42	616	229
40	473	676
77	491	89
54	175	51
158	277	42
42	260	571

59	135	1097
535	74	126
205	324	34
275	40	58
27	41	126
266	47	39
36	36	127
130	276	118
28	113	35
52	27	53
93	184	641
270	156	48
93	245	30
257	135	52
73	907	89
571	277	113
344	37	56
88	94	59
83	68	174
291	48	60
60	132	421
74	280	201
200	28	156
218	59	25
115	31	492
64	41	53
60	35	310
105	405	57
65	765	107
257	211	31
209	631	76
103	97	41
577	111	168
51	121	206
36	416	33
280	50	168
69	91	40
152	540	33
632	46	48
185	33	35
38	126	222
192	79	53
74	289	40
213	158	66
70	179	100
140	695	80
77	381	418

206
124

80
404

188
42

Non-diabetic subject #4 at 81 mg/dL glucose level

361	519	786
68	381	910
173	146	117
256	123	232
328	243	2127
212	85	494
512	78	31
101	117	31
265	105	872
47	133	1158
109	115	225
152	130	312
306	128	33
145	96	97
78	372	887
103	56	67
26	163	757
115	44	677
37	264	47
156	251	668
213	35	162
124	39	220
53	418	333
145	75	85
620	78	267
300	162	121
76	94	66
56	82	338
76	91	111
121	227	290
138	36	187
212	25	452
180	275	55
384	130	213
50	120	273
110	159	42
194	134	38
255	128	278
294	178	631
125	65	80
102	58	96
207	284	242
102	166	174
26	252	39
466	240	177

66	507	34
428	508	552
77	161	235
453	703	53
48	73	32
40	81	140
374	75	56
142	74	336
371	33	327
55	98	573
88	24	390
129	150	416
82	82	32
313	165	450
66	585	129
78	129	2148
264	353	60
64	261	1104
238	92	276
479	130	229
125	183	46
115	91	70
91	70	41
417	435	39
85	132	30
72	366	37
397	285	283
756	84	26
64	132	55
49	72	142
103	443	243
56	114	190
52	639	1669
111	43	327
51	237	220
178	496	94
40	498	38
143	217	179
32	163	315
230	248	120
97	341	535
52	186	74
352	216	44
113	54	779
108	32	332
490	443	497
102	48	148

201	249	240
322	238	90
166	641	981
67	288	495
985	32	513
137	47	193
57	208	147
926	193	83
152	121	66
39	66	307
299	338	203
30	111	159
65	290	325
861	187	64
202	452	792
306	93	115
268	91	736
240	49	175
205	272	32
324	74	83
255	251	317
204	248	70
742	231	84
294	78	218
949	150	85
578	169	46
513	362	128
456	63	82
280	445	44
38	64	117
237	434	51
658	61	454
150	62	153
146	50	345
345	39	126
76	355	34
608	70	462
145	76	30
37	75	424
386	47	51
543	162	40
34	506	404
48	214	123
288	150	168
251	90	229
102	37	130
181	904	545

109	225	55
324	191	422
111	58	28
463	57	35
218	73	373
45	324	96
425	847	289
53	67	95
177	158	51
183	31	106
169	74	98
870	334	66
161	164	240
306	334	106
402	156	147
147	310	58
119	602	652
63	484	46
54	86	75
463	347	243
36	127	180
276	30	316
149	500	257
404	507	618
660	507	156
73	769	285
461	293	84
430	301	154
160	240	114
52	459	641
52	92	205
950	65	41
550	362	1084
317	126	75
360	269	296
153	270	141
55	524	46
712	260	1142
116	263	97
31	533	292
122	538	284
145	547	38
217	454	204
103	33	32
106	312	157
28	75	56
125	155	36

700	411	54
472	306	219
765	247	81
64	78	130
34	520	450
46	439	53
36	36	4919
197	64	867
348	65	1105
31	38	444
27	112	41
45	145	252
187	90	484
54	68	246
238	445	85
77	946	1453
134	168	32
244	538	36
179	227	30
87	769	124
364	72	118
121	112	132
235	146	186
699	252	88
168	103	63
511	82	936
147	115	67
364	60	31
235	29	37
249	95	751
34	484	43
673	72	34
52	419	262
256	97	231
58	44	106
194	38	612
40	159	683
489	269	51
35	383	322
940	402	2011
856	259	982
58	714	38
24	34	42
157	443	275
34	123	41
592	222	294
684	147	1150

32	152	62
39	93	278
67	252	4064
383	439	1958
414	47	53
28	97	478
189	104	203
69	47	326
178	103	36
36	137	42
177	29	103
54	92	855
207	425	129
119	205	114
127	133	795
195	96	449
194	74	255
147	68	300
69	49	477
196	104	494
683	140	170
96	151	175
121	423	43
49	98	491
273	506	710
126	51	206
124	174	361
600	124	241
74	174	38
306	329	42
133	52	29
546	123	227
347	64	130
35	56	36
27	345	43
83	32	37
143	425	113
142	567	46
104	741	231
306	684	47
42	337	201
268	258	319
254	335	231
61	205	77
49	91	106
128	92	67
134	251	35

123	216	150
143	67	358
31	33	205
26	131	2061
38	191	271
51	104	284
59	35	154
110	35	174
43	511	306
44	113	123
42	29	42
119	383	34
38	83	246
447	350	124
49	76	767
488	227	36
178	285	31
302	519	178
151	514	210
323	514	57
351	518	33
111	506	187
31	288	94
154	43	23
327	291	205
300	26	112
146	172	42
41	157	61
471	559	420
221	190	66
260	46	58
519	106	66
81	31	41
144	61	51
201	156	29
42	213	28
42	55	54
390	32	201
214	39	44
210	61	172
31	48	53
145	54	38
92	742	53
710	489	82
228	477	152
494	578	177
93	408	60

687	479	101
218	457	115
378	454	176
40	341	99
79	183	86
70	122	137
148	58	69
119	77	39
62	78	68
36	150	86
84	161	129
40	124	127
201	68	52
174	105	193
49	117	63
36	69	50
114	275	164
85	152	38
136	228	354
122	439	41
178	195	101
65	107	269
63	23	363
294	125	68
66	122	41
187	293	227
39	164	30
34	288	33
188	72	401
75	844	72
32	115	190
100	231	89
311	376	391
61	290	47
119	65	295
148	223	190
71	109	1359
70	52	42
90	112	3726
109	141	3517
117	56	983
220	54	321
53	240	608
52	407	4178
211	83	347
43	136	2826
84	346	738

187	351	77
95	93	136
42	41	26
287	161	282
153	178	578
107	699	131
199	193	621
606	58	2216
180	57	27
494	530	838
490	360	241
374	39	474
105	36	78
492	569	308
501	960	28
501	211	499
495	109	389
514	116	365
520	51	803
406	27	189
114	123	141
434	270	318
85	32	940
971	136	141
242	118	421
33	32	177
52	164	161
41	55	28
160	315	330
246	55	416
188	80	48
70	39	236
622	44	453
35	38	42
66	36	161
225	97	112
75	374	75
513	74	176
428	351	56
87	298	34
122	252	196
127	159	120
35	103	151
133	269	744
89	149	107
291	63	184
144	189	59

85	81	39
510	768	244
86	345	47
354	41	32
37	58	408
151	37	49
286	308	128
81	172	175
78	47	788
216	397	262
86	52	960
189	43	619
305	51	38
99	100	268
60	465	786
67	63	910
35	54	117
57	113	232
93	48	212
132	55	494
210	44	31
169	39	31
95	42	872
83	103	115
116	58	225
51	116	312
58	76	33
86	276	97
44	40	887
49	62	67
503	444	757
328	65	677
184	177	47
523	200	668
105	33	162
52	42	220
589	60	333
144	211	85
162	47	267
25	285	232
98	115	38
445	35	36
541	106	699
59	45	388
554	116	423
117	55	54
168	70	502

106	31	28
315	255	47
28	118	377
222	36	242
998	66	301
50	73	800
159	30	120
278	38	247
175	43	388
52	195	176
57	175	648
178	146	85
39	241	735
54	100	876
263	193	898
37	154	29
48	175	127
65	96	54
83	49	552
43	273	901
556	347	48
65	339	378
173	53	206
76	544	409
33	51	560
249	75	30
272	61	466
69	106	167
73	29	353
348	96	989
520	51	39
447	65	221
48	72	56
40	145	278
277	164	169
264	59	114
144	303	119
103	53	61
32	138	38
61	94	149
42	44	499
69	48	222
370	308	195
81	202	127
129	33	280
569	196	39
38	329	129

686	51	176
854	185	295
41	68	221
108	135	48
81	46	445
42	34	1
41	286	34
281	165	40
28	238	40
325	173	108
360	136	190
321	44	132
130	185	145
32	55	134
240	139	206
231	41	670
108	29	402
48	100	1784
179	47	3488
349	89	387
345	135	252
29	42	918
170	47	458
263	363	172
72	42	172
32	56	92
52	75	313
72	34	96
71	129	165
129	48	453
71	354	66
49	35	108
167	102	134
194	106	98
121	37	284
75	50	129
81	908	307
80	585	143
225	240	314
43	351	90
39	102	172
96	355	823
483	34	225
492	264	145
498	736	159
198	629	98
313	346	243

200	417	27
313	28	56
514	473	29
468	213	30
32	340	136
492	57	292
401	37	99
107	2427	41
96	492	84
208	77	46
60	60	222
39	253	179
570	779	213
25	115	122
97	24	174
43	52	130
123	234	59
130	149	86
101	36	37
269	62	71
149	31	239
72	55	63
377	29	41
110	71	73
122	390	115
122	66	26
158	39	123
82	346	60
251	33	94
250	39	27
503	40	39
523	27	29
502	100	132
159	27	1
210	97	
185	41	
397	45	
112	32	

Non-diabetic subject #4 at 158 mg/dL Glucose level

18	134	429
109	767	473
64	466	472
268	385	140
251	79	319
34	444	468
172	138	390
104	301	80
39	244	474
240	152	138
93	45	262
40	284	77
154	186	151
92	364	316
368	86	416
110	230	70
258	210	371
383	391	113
406	74	248
428	340	313
435	126	181
146	137	449
234	222	24
51	120	99
194	378	34
294	72	54
39	460	43
160	457	421
42	261	43
104	52	310
334	62	64
86	67	377
114	211	32
73	148	27
98	75	44
119	431	45
44	443	437
35	57	183
119	76	75
65	304	149
44	76	269
38	349	78
41	371	143
53	69	178
123	387	156

92	75	141
42	344	332
29	36	428
41	76	49
66	308	27
42	133	308
33	132	92
94	252	81
31	65	27
438	327	126
429	60	73
321	74	324
190	375	125
211	64	192
36	70	83
39	293	179
66	67	317
41	289	137
39	86	371
52	382	77
87	122	429
68	426	35
96	368	205
151	279	143
56	110	42
43	44	45
141	66	37
554	34	138
127	446	349
135	62	464
174	41	137
97	106	240
53	145	116
285	27	142
492	142	273
63	129	84
89	137	145
31	90	225
37	299	36
63	54	80
32	56	71
76	447	307
52	488	92
123	368	363
330	320	82
28	103	140
27	357	253

124	77	79
165	442	100
61	130	175
44	236	127
77	64	92
27	238	82
144	181	269
56	351	50
52	78	81
43	178	87
39	175	307
111	95	82
171	432	469
53	217	141
104	221	313
161	353	162
218	75	309
107	443	461
403	249	395
143	201	82
268	368	403
133	82	80
37	135	216
303	296	53
297	138	193
558	228	257
214	83	124
435	38	80
735	332	390
155	90	79
323	212	140
143	156	338
33	67	288
46	391	74
137	78	102
196	364	449
169	74	68
40	363	394
132	78	326
244	384	61
48	79	67
257	478	390
194	314	77
164	146	298
244	248	141
199	123	64
33	74	286

97	378	108
29	78	270
58	372	111
26	79	76
29	97	320
156	39	482
53	297	75
271	350	448
154	80	141
81	360	120
69	70	109
197	447	78
144	362	358
35	77	72
93	345	361
152	76	79
58	144	367
45	281	90
60	294	390
115	137	75
82	104	214
40	274	155
64	71	72
96	273	299
205	86	156
265	66	134
123	414	214
40	231	104
50	196	378
260	371	60
257	55	329
58	200	117
68	208	365
216	412	75
64	329	449
29	99	26
41	98	403
97	37	568
96	142	144
58	142	125
161	351	214
313	76	141
275	365	169
234	77	99
54	371	73
32	75	442
100	51	48

331	380	46
357	130	95
47	288	32
69	324	99
314	24	33
386	36	87
70	37	58
42	349	308
45	74	317
144	206	45
56	129	40
34	75	28
45	146	125
209	267	201
105	422	82
195	104	136
36	264	288
35	76	132
361	135	307
143	292	59
59	349	346
83	57	79
40	457	134
282	139	249
374	237	80
130	69	409
40	436	42
152	218	125
26	232	241
94	374	57
54	74	476
337	140	140
52	318	185
28	390	53
47	69	48
47	314	43
47	127	287
31	353	67
108	98	75
190	154	140
154	73	294
58	294	447
151	163	462
59	405	353
37	76	103
46	409	348
51	80	35

55	60	81
72	117	407
74	238	70
66	78	186
30	367	207
49	141	91
114	378	369
87	53	90
56	35	433
45	46	397
114	69	79
121	435	274
77	91	208
132	129	422
297	188	53
67	80	36
51	399	198
167	79	247
137	473	391
152	467	80
169	314	89
32	31	53
69	80	253
53	91	76
101	304	466
141	86	420
60	75	218
56	318	229
58	30	140
25	50	207
339	111	92
106	53	79
51	129	63
92	185	240
172	47	76
80	80	244
138	139	40
77	238	162
29	464	147
57	81	70
27	57	234
49	289	323
98	80	55
29	69	77
96	72	329
26	286	33
109	424	80

192	210	427
134	149	183
237	77	171
53	68	73
363	364	138
78	358	143
205	79	168
92	79	438
69	375	293
53	410	65
143	92	67
89	352	148
121	112	217
60	392	77
207	81	86
224	399	363
360	84	188
63	396	308
364	79	285
76	242	155
381	139	134
58	79	227
414	346	87
354	129	256
78	368	47
265	65	142
439	27	309
341	250	145
38	116	380
76	74	67
384	257	430
77	194	305
366	369	70
55	80	66
386	343	143
76	32	65
378	73	162
77	360	76
378	76	318
78	341	
272	59	
160	298	
140	113	
122	396	
86	116	
79	240	
362	62	

Non-diabetic subject #5 at 78 mg/dL glucose level

82	132	78
33	58	77
205	189	51
326	218	1145
70	36	177
76	64	632
163	40	612
139	28	547
94	26	5512
201	69	784
175	61	632
265	89	818
75	42	83
209	88	52
103	193	3495
38	134	61
120	79	237
33	46	229
50	101	37
42	190	51
258	57	32
43	170	69
46	48	55
74	30	371
44	31	131
204	194	30
121	119	291
93	127	219
120	64	126
90	51	764
202	63	259
209	91	510
80	244	476
45	192	301
45	49	61
36	31	43
207	367	106
113	187	191
39	139	193
88	89	36
81	155	120
90	74	90
53	59	198
161	142	227
101	44	341

151	37	47
26	85	42
379	204	521
149	125	83
149	113	277
142	403	788
41	305	86
100	455	344
45	58	421
273	49	286
59	121	38
76	234	40
36	293	36
297	57	328
421	31	76
70	124	41
86	197	145
60	159	555
46	42	498
130	218	152
113	29	705
104	298	37
106	44	164
73	176	138
45	66	98
191	45	434
58	91	276
149	322	160
228	33	322
77	60	421
29	70	47
203	81	152
54	88	39
35	88	246
144	95	287
204	66	131
26	65	74
276	360	671
263	300	182
93	361	494
164	26	478
56	65	36
247	144	120
332	117	46
71	103	394
194	68	105
80	354	85

47	98	42
176	314	83
69	100	96
179	156	54
93	40	32
64	68	41
488	68	59
146	432	63
59	290	59
153	115	281
52	508	74
39	53	92
53	43	26
37	157	78
81	107	525
118	418	400
48	227	85
40	55	183
65	67	173
58	433	65
136	78	47
73	641	62
117	885	115
135	168	120
656	160	29
104	245	28
39	67	155
71	341	64
75	308	233
86	604	48
136	102	41
264	74	39
59	192	32
94	80	33
118	46	302
53	201	104
150	105	171
41	141	328
86	36	76
37	49	111
70	115	62
211	47	29
106	59	199
235	97	137
59	98	107
69	286	182
43	244	806

26	64	244
68	47	259
34	45	91
246	248	46
181	61	69
83	257	52
76	70	40
98	68	509
45	87	40
221	204	453
118	32	63
301	65	33
32	47	246
152	166	155
66	274	409
75	46	413
139	25	234
266	64	179
203	80	432
80	88	430
227	188	450
83	124	296
28	48	142
624	58	443
88	53	411
476	40	183
87	128	837
145	84	78
135	146	41
163	56	902
343	56	117
86	37	58
29	34	35
75	133	45
132	56	153
99	133	672
64	112	102
155	88	134
60	238	54
39	31	241
122	73	215
173	42	218
31	81	114
263	61	82
97	47	41
115	26	57
93	77	40

41	153	68
221	56	157
30	80	30
244	39	88
53	177	45
54	130	46
49	110	65
288	56	69
42	60	50
164	179	47
33	124	184
31	115	195
389	29	749
362	76	532
160	300	47
45	347	104
29	150	187
26	105	432
74	108	243
38	121	67
63	140	127
107	62	363
95	193	77
149	190	435
64	82	650
42	77	145
144	140	141
136	160	62
235	71	275
161	336	27
53	107	163
57	36	38
73	63	602
341	57	126
30	134	381
138	52	129
212	154	112
31	59	214
208	127	55
59	79	63
67	83	67
45	230	27
51	94	122
196	57	737
78	56	316
53	77	90
38	111	304

146	234	114
35	195	151
27	63	52
191	142	151
83	31	115
74	166	67
39	150	51
72	70	30
67	64	110
53	71	71
53	153	35
51	84	63
117	62	360
300	228	61
65	191	57
32	58	48
35	29	42
58	154	55
499	47	77
42	42	324
491	170	114
190	46	85
266	354	59
146	98	86
116	45	43
47	126	71
47	128	36
35	28	64
146	558	35
36	241	121
58	31	176
48	168	164
32	282	126
72	136	55
334	69	118
148	340	176
388	75	152
429	347	50
53	427	127
102	39	68
71	107	46
46	71	160
42	135	70
39	74	347
59	79	138
108	40	44
65	67	671

76	49	167
32	181	122
87	444	43
62	453	143
180	461	41
350	195	84
195	282	30
37	383	71
75	84	34
190	456	33
85	404	104
175	41	52
59	135	48
115	239	93
85	65	42
101	155	87
81	184	37
45	106	181
75	50	39
191	229	52
128	129	111
94	73	34
48	239	666
77	115	37
132	39	404
61	63	28
66	220	55
123	71	45
25	249	101
30	262	263
30	51	110
111	57	157
168	90	26
112	105	26
105	69	27
76	149	173
53	43	124
92	32	38
92	110	376
58	403	100
119	52	130
260	61	133
223	36	74
109	88	57
46	26	64
32	189	38
39	611	64

63	41	153
74	28	52
59	305	59
47	25	30
47	338	26
213	102	41
55	24	1137
175	83	56
82	56	31
81	86	51
73	77	171
182	39	243
115	46	144
242	100	85
337	378	106
37	63	373
62	79	147
47	44	28
140	511	65
175	117	67
204	231	95
202	75	106
63	155	39
461	122	27
103	146	173
28	322	447
224	26	212
82	429	160
58	49	71
136	186	25
75	247	96
40	26	111
34	253	95
80	29	139
59	380	360
64	228	195
107	292	93
73	151	34
39	194	92
218	228	59
43	24	75
57	360	131
40	80	49
71	613	127
34	53	286
178	42	52
106	47	72

58	522	67
56	252	78
64	168	121
166	358	54
105	73	123
66	370	67
206	458	35
68	62	525
225	353	89
278	33	59
73	78	137
211	296	143
46	83	93
139	98	57
102	315	205
246	125	213
53	85	87
271	29	253
85	351	63
25	225	68
41	43	97
85	85	42
48	68	159
62	28	64
134	148	124
90	168	97
38	120	37
68	69	103
35	54	78
48	50	153
37	116	112
61	238	115
107	233	367
104	98	94
264	28	104
39	329	88
134	269	29
142	160	77
35	141	215
138	92	74
361	41	123
361	98	46
186	150	40
39	68	59
59	365	415
86	285	73
55	30	46

136	125	374
38	212	76
149	228	80
27	63	286
38	95	179
35	42	59
40	48	103
58	170	77
52	45	73
101	39	145
165	212	241
115	64	60
105	29	115
207	113	35
50	105	205
64	482	64
63	90	62
132	675	43
34	42	90
27	200	110
194	45	292
49	92	89
492	34	84
81	45	31
25	199	72
77	46	33
76	34	253
74	29	115
185	201	87
34	33	128
38	81	144
76	29	147
75	40	26
222	99	58
196	29	169
157	24	56
95	126	100
37	150	64
188	51	71
910	151	339
57	114	37
114	181	207
35	34	62
176	69	55
103	53	114
52	27	86
101	111	294

170	115	261
30	58	131
32	57	43
59	35	112
173	138	37
40	38	208
176	200	106
264	62	30
60	153	25
128	41	125
154	32	78
74	124	32
301	72	43
92	33	58
83	112	87
149	58	221
154	29	101
118	38	123
31	286	121
81	31	97
36	78	294
91	39	167
91	41	168
254	45	182
50	70	207
53	56	30
124	182	102
74	125	46
66	36	135
29	53	30
78	197	38
57	30	40
69	133	44
93	244	67
45	184	69
130	191	97
137	58	60
352	46	142
208	131	65
188	39	79
177	78	55
40	238	58
226	60	100
247	71	143
40	84	339
114	64	196
172	78	142

133	253	120
56	104	244
151	54	56
145	273	429
65	74	83
429	277	165
213	58	217
183	131	57
161	37	431
130	148	291
75	37	312
58	168	60
39	32	56
214	47	52
26	37	93
60	30	75
28	45	58
53	96	181
56	141	199
76	177	49
51	55	258
55	1557	98
77	50	36
76	516	118
262	42	50
61	602	42
56	199	35
52	256	32
42	35	167
80	35	35
80	5059	88
50	162	39
487	153	69
120	170	192
97	26	95
433	208	129
360	39	227
52	255	78
63	797	36
151	65	72
176	239	41
101	41	106
184	214	233
59	75	69
31	40	43
38	67	69
62	217	88

73	36	219
38	102	31
35	30	44
89	206	42
264	157	226
216	55	83
87	89	114
158	112	120
31	62	304
356	270	136
161	214	62
40	32	37
140	78	159
105	52	504
85	120	125
139	56	148
303	48	58
85	65	382
48	92	231
43	47	159
43	72	33
86	101	404
531	29	185
41	501	57
113	35	50
614	922	74
67	68	49
271	52	80
38	191	115
213	862	205
31	30	61
253	36	118
65	165	47
83	310	25
129	29	35
436	284	68
144	201	64
219	290	28

Non-diabetic subject #5 at 148 mg/dL glucose level

151	62	29
1066	37	43
514	121	44
536	461	162
552	595	55
529	534	80
525	130	134
467	115	166
77	96	124
538	265	62
787	160	108
148	435	80
335	354	130
231	117	64
60	56	40
31	28	125
80	214	50
43	203	147
39	125	341
29	246	167
69	56	92
54	136	67
56	152	223
375	231	126
101	44	35
36	95	316
35	59	45
73	45	360
497	57	158
112	67	80
473	40	150
44	59	186
36	37	163
63	63	127
96	26	119
268	80	39
75	140	65
72	75	49
379	31	183
33	44	48
53	42	467
65	42	90
73	190	28
30	67	266
244	177	63

46	119	227
352	272	50
116	75	25
148	60	44
36	341	39
147	51	48
129	84	53
56	742	78
151	231	180
47	37	269
26	41	302
282	307	45
203	62	40
439	30	48
61	70	162
81	89	126
37	537	31
319	56	277
79	81	75
143	40	153
42	67	876
38	35	151
219	33	264
177	273	26
127	50	42
214	53	24
218	114	489
423	249	161
30	84	291
29	68	42
32	89	143
518	60	34
30	404	46
224	99	207
63	28	72
110	216	40
454	118	277
133	67	889
171	182	220
57	84	323
307	123	42
46	88	404
50	385	169
43	60	50
57	29	51
53	81	32
247	148	35

109	396	251
367	110	295
54	35	170
39	450	313
330	88	91
138	479	122
38	59	56
62	257	122
45	260	33
296	34	44
543	31	83
226	377	344
609	54	87
36	44	64
125	551	85
62	183	55
151	70	258
45	103	29
52	106	126
66	42	42
417	556	788
27	28	45
135	53	43
415	68	57
27	52	470
351	69	369
106	29	72
44	163	220
435	347	61
384	48	118
459	69	110
1289	325	85
285	263	194
120	71	79
45	75	63
813	90	45
705	573	182
832	28	56
271	45	71
85	55	459
63	98	158
65	220	55
91	65	27
283	62	376
80	608	197
33	121	192
265	50	435

71	47	118
92	69	256
46	324	387
259	83	648
50	131	238
45	204	195
409	258	293
71	347	49
62	260	190
110	32	440
339	29	193
250	32	104
80	46	31
237	392	79
424	202	127
491	54	197
102	49	47
113	125	387
30	60	202
364	109	658
35	48	195
304	149	51
151	180	47
145	421	281
143	99	798
220	197	105
29	317	507
43	129	24
574	120	536
56	57	155
175	30	179
304	346	112
43	311	675
234	76	207
527	333	590
139	157	215
554	297	178
34	223	302
152	177	114
52	225	308
149	99	140
180	72	154
133	179	382
96	29	218
90	167	375
103	91	375
69	451	27

142	111	150
48	94	322
48	67	122
269	388	43
37	78	35
88	189	194
224	127	27
286	217	48
37	66	37
615	317	120
45	113	247
193	41	47
543	28	66
387	480	73
37	45	30
52	70	74
782	64	40
49	163	55
38	54	79
154	87	377
72	182	38
186	98	79
148	53	74
250	423	617
859	46	50
286	81	42
526	105	40
522	36	51
219	83	45
185	134	217
857	376	40
273	77	335
119	33	283
149	156	41
120	246	41
161	128	41
225	380	345
207	98	352
50	548	105
65	623	146
414	529	130
148	501	180
59	518	52
164	533	26
417	539	267
237	549	42
638	550	130

138	347	112
167	197	168
45	148	46
159	382	140
116	452	51
28	76	125
86	430	456
46	73	173
101	518	53
49	534	65
61	466	57
153	71	68
211	108	147
289	328	122
69	221	219
54	759	83
48	83	503
72	84	60
416	47	40
100	77	58
129	332	41
188	35	32
194	306	81
41	179	52
39	206	34
70	25	60
77	53	513
330	77	51
105	243	312
458	167	594
419	470	39
69	72	26
509	316	410
194	231	54
164	542	29
166	528	459
526	995	953
444	669	45
69	67	35
520	444	56
539	512	51
324	248	122
224	410	356
546	966	213
531	59	70
431	50	46
87	107	147

511	568	32
509	61	487
500	32	239
499	44	197
332	265	37
72	133	248
91	459	291
513	74	173
307	423	29
190	116	493
299	562	372
731	578	96
524	99	57
513	508	126
524	587	62
501	585	525
513	929	50
326	247	24
188	580	48
501	574	35
525	571	306
530	555	54
515	558	49
483	559	36
508	573	58
513	551	258
505	107	38
864	155	672
156	331	258
505	72	51
157	541	50
203	432	204
637	371	52
493	219	55
419	452	209
43	74	43
30	524	280
507	857	37
534	192	492
546	522	60
531	316	36
537	66	56
531	29	109
529	678	241
514	411	130
523	304	151
534	348	237

366	83	62
149	33	26
530	222	115
546	128	489
458	32	36
90	44	36
157	98	54
512	379	592
346	50	93
518	175	55
457	59	100
73	77	38
528	40	156
532	142	38
289	227	55
265	36	226
455	333	54
76	335	40
533	219	302
545	51	258
302	804	201
234	555	57
286	572	41
199	765	145
120	916	53
416	84	39
40	219	77
555	340	28
240	29	69
764	434	40
61	36	330
110	148	229
231	211	71
201	93	45
467	53	41
77	772	75
127	56	179
165	70	150
102	86	69
63	113	221
77	63	218
353	44	337
195	279	85
387	54	810
77	55	28
399	63	61
198	43	662

106	191	35
322	358	29
107	70	76
513	72	486
43	44	86
99	110	26
181	530	45
58	92	206
190	39	76
477	69	59
74	236	59
376	56	127
136	42	410
45	54	32
32	39	44
62	314	34
355	586	233
60	72	27
480	61	138
447	38	33
74	586	241
516	344	202
115	227	26
89	39	483
236	481	343
45	71	270
178	82	633
48	96	270
226	288	37
104	68	155
539	378	92
551	925	42
514	67	31
539	234	44
792	329	263
504	64	66
482	58	26
52	53	73
87	278	41
37	32	29
29	124	473
369	43	409
225	26	389
136	556	187
50	44	50
145	176	152
169	51	99

440	59	451
61	217	196
674	35	261
413	212	162
72	169	50
42	236	85
616	612	28
561	32	66
566	152	230
308	60	121
230	34	47
297	702	96
153	434	50
349	162	72
662	119	995
26	39	270
51	27	56
69	137	505
174	284	45
174	500	62
639	443	526
198	793	524
496	46	335
664	43	134
604	265	49
431	170	418
48	43	102
52	44	715
464	38	24
183	60	124
65	64	25
867	209	84
235	113	90
531	58	104
117	43	85
113	184	372
137	73	825
82	153	544
63	272	45
370	112	306
259	120	543
44	84	154
45	43	681
60	297	275
84	214	491
147	47	322
571	66	60

27	196	110
137	148	610
216	39	144
397	29	82
33	49	364
62	59	105
305	41	46
54	170	225
55	162	144
58	62	376
201	55	772
301	278	251
60	169	133
38	225	801
40	278	194
518	135	170
440	58	234
294	46	701
58	231	201
57	126	75
41	99	47
320	43	274
34	60	58
404	282	54
212	40	1051
373	60	308
436	45	38
445	122	145
125	45	134
243	55	102
61	48	140
285	436	113
38	108	177
467	201	243
117	28	437
54	233	54
94	103	147
31	103	147
172	32	81
41	48	289
66	74	155
75	83	65
98	362	179
409	435	53
44	185	52
229	617	529
214	32	485

75	96	111
48	440	397
56	178	131
60	417	73
75	67	246
231	145	42
39	558	484
26	235	416
41	80	348
34	89	220
97	115	489
90	152	499
59	158	290
91	119	696
118	143	311
219	39	29
362	210	146
117	981	401
30	162	276
154	34	92
84	329	73
130	62	680
141	54	312
128	71	330
46	175	121
274	238	542
242	479	431
40	915	143
55	73	53
55	499	79
581	314	131
388	92	122
158	97	49
395	440	167
122	73	258
586	364	47
546	26	50
298	49	343
578	90	46
57	327	150
101	361	178
126	89	35
64	101	31
73	67	133
42	77	35
413	83	32
306	157	468

146	122	398
357	83	158
50	63	179
28	67	168
33	227	321
121	210	66
339	154	156
41	35	86
47	388	140
42	39	420
836	47	81
133	89	43
54	126	37
163	283	231
318	151	305
110	24	49
35	118	140
45	63	81
405	240	27
60	90	56
769	31	202
116	76	801
53	32	93
145	39	30
540	344	170
382	64	162
74	149	78
53	88	30
268	38	48
28	154	39
102	57	95
684	146	50
319	306	152
440	63	199
389	45	92
142	88	37
78	53	74
310	68	280

Diabetic subject #1 at 73 mg/dL glucose level

282	52	246
88	31	88
298	28	263
116	125	53
40	92	116
545	50	69
344	63	45
102	156	305
319	89	135
326	92	94
90	54	249
365	502	38
438	112	59
104	41	511
275	47	34
67	228	82
35	214	274
380	225	92
73	258	69
390	64	290
77	101	95
725	150	139
565	124	65
59	239	89
33	252	35
49	280	60
115	145	287
210	280	149
117	130	34
31	79	213
48	178	120
129	198	38
308	150	69
412	225	61
40	155	575
33	141	160
70	173	371
335	160	68
30	25	78
347	73	43
33	126	49
185	33	430
67	163	315
553	30	38
312	352	59

79	39	24
480	311	81
403	204	317
77	62	137
385	64	36
96	215	245
409	266	43
77	94	253
99	60	34
258	716	241
44	227	268
57	337	145
311	73	289
413	128	191
146	207	272
73	293	34
364	240	43
257	341	276
149	38	50
92	72	311
424	240	54
359	159	125
208	446	97
683	28	331
105	66	823
883	297	66
104	173	130
405	188	584
77	169	406
479	421	38
133	35	161
36	84	280
42	155	283
34	120	187
51	96	291
60	420	149
488	146	295
98	144	205
779	140	297
31	62	530
71	31	625
433	366	88
220	95	482
218	226	321
153	125	158
302	236	377
385	134	93

469	154	528
87	131	260
122	324	33
300	223	41
31	99	29
184	109	360
334	196	41
778	47	30
162	114	140
863	240	203
66	190	75
101	70	308
31	196	195
250	235	114
72	710	110
149	382	887
222	231	538
149	262	388
30	259	429
144	256	561
156	51	305
397	48	219
462	391	491
357	30	472
96	35	39
632	107	77
139	243	398
351	138	234
57	256	57
29	171	265
37	38	90
43	66	198
44	343	40
383	445	211
103	56	245
146	36	94
69	343	62
156	87	234
73	58	61
120	200	87
77	156	400
131	349	39
65	87	64
43	193	149
59	145	50
42	28	106
92	68	140

35	367	311
31	298	279
35	49	183
394	89	141
120	235	91
74	186	991
620	40	525
38	94	137
133	340	282
79	129	403
63	59	438
39	133	330
183	180	48
158	210	89
157	226	220
304	99	66
297	112	98
158	642	61
191	62	58
260	320	138
63	70	88
52	145	36
210	220	736
140	50	29
101	167	104
29	57	86
172	46	27
145	110	61
350	44	25
377	151	223
403	289	58
369	282	230
145	148	43
75	513	33
369	367	120
684	37	96
63	473	118
46	152	75
101	65	106
75	45	35
211	34	54
572	31	272
519	311	493
75	129	30
103	92	357
111	168	117
722	95	153

468	70	80
284	216	28
66	263	386
483	346	35
415	51	71
54	50	338
140	315	54
250	140	368
401	366	69
86	59	62
492	185	50
184	261	377
158	336	112
43	69	65
430	429	86
74	95	175
73	326	70
199	62	60
160	31	276
141	85	180
91	69	49
195	60	154
217	49	201
67	31	30
159	53	61
452	176	192
386	85	172
271	55	120
189	50	171
131	355	175
240	94	64
153	272	116
327	50	49
138	153	428
116	140	113
579	28	150
76	149	64
450	101	276
920	40	389
386	59	315
76	182	227
392	49	50
30	90	43
499	35	78
439	35	84
451	149	35
298	76	84

330	76	62
110	40	71
924	112	389
76	227	83
351	66	114
30	275	333
70	134	44
390	632	45
73	436	74
377	80	706
211	79	65
219	24	46
81	35	48
79	166	65
180	114	56
121	30	78
100	73	62
55	30	135
26	51	359
62	300	30
306	71	89
395	331	63
104	184	28
240	38	141
151	189	151
270	51	29
313	359	56
42	233	75
74	63	38
63	130	67
287	294	219
89	111	164
88	124	56
289	51	58
907	286	172
212	150	90
319	93	71
390	251	268
285	131	141
146	171	92
306	164	59
120	127	32
53	375	83
273	65	155
398	29	115
74	78	40
37	142	34

76	82	265
414	42	116
34	110	244
81	896	86
62	540	114
54	30	28
87	70	38
57	230	245
104	72	59
166	100	46
99	482	70
45	64	194
46	143	166
116	66	35
693	60	147
426	100	137
66	94	111
351	106	142
25	254	217
450	186	138
65	235	48
338	80	43
323	270	197
417	146	126
438	230	40
106	421	76
53	160	36
123	49	66
461	33	55
46	273	87
57	78	63
108	163	56
139	120	58
58	177	183
153	71	114
29	611	406
261	195	70
32	25	145
55	220	49
45	130	57
76	65	136
37	94	317
128	102	112
71	75	89
67	161	67
29	91	88
88	144	41

181	194	110
51	28	33
171	65	56
51	337	193
57	161	408
181	185	31
34	87	414
325	72	151
54	60	315
512	30	52
44	61	41
101	189	27
57	87	364
232	118	254
28	145	835
39	56	112
30	401	30
437	85	53
57	161	754
47	108	617
41	45	266
411	65	46
23	285	330
27	50	53
166	173	66
251	639	41
314	138	495
231	29	31
399	243	45
43	154	85
74	181	46
202	120	87
67	94	380
56	87	88
81	65	25
33	239	43
201	509	39
80	31	65
56	85	58
167	346	893
217	71	37
68	362	123
60	75	164
72	172	507
32	53	41
35	201	107
42	48	42

150	451	167
58	27	60
80	154	83
104	171	58
345	100	256
611	265	67
365	69	39
33	65	46
62	211	45
152	144	29
29	64	31
364	74	40
36	72	164
122	33	84
573	229	264
313	174	35
65	69	46
143	91	76
69	314	134
42	53	116
38	52	191
92	57	65
174	27	169
153	56	76
122	320	45
849	61	87
235	36	41
38	28	56
26	95	289
453	86	101
34	64	51
44	116	350
747	166	97
777	28	85
46	122	50
601	44	62
425	121	297
657	171	58
54	73	578
281	686	48
395	143	38
28	350	142
41	152	43
142	127	32
63	156	60
171	52	44
431	100	44

380	268	283
66	741	269
64	41	34
33	267	49
62	182	53
326	237	81
65	160	133
72	64	233
99	64	380
249	192	280
119	170	37
117	145	110
107	40	332
134	35	475
291	100	89
105	101	45
122	395	260
530	39	110
728	94	54
256	108	294
49	44	293
198	34	65
28	375	246
33	130	193
133	138	363
57	73	44
25	85	116
59	180	33
121	113	271
146	29	34
32	885	145
292	310	43
718	39	39
185	98	199
78	28	44
37	184	204
134	44	167
144	81	113
84	400	38
63	144	53
33	157	29
191	40	158
86	115	423
136	295	630
49	77	820
299	138	289
78	291	216

51	130	49
91	39	168
162	145	58
51	84	110
45	138	112
62	354	322
28	26	371
84	395	1120
318	137	65
29	231	56
145	484	344
576	44	50
192	37	34
371	39	475
358	63	32
128	288	278
86	77	796
275	36	26
151	735	44
361	40	86
359	149	89
212	59	150
119	29	65
104	66	81
232	63	314
216	59	66
886	71	39
421	60	357
93	75	143
54	42	54
157	244	232
146	79	34
416	87	42
301	292	25
145	145	157
161	146	30
266	40	175
503	36	191
95	50	65
250	144	55
195	94	141
258	345	175
503	103	424
329	365	412
28	40	195
247	37	71
55	357	62

40	93	366
126	82	41
255	110	485
26	65	44
104	45	155
530	39	165
88	28	41
277	73	790
65	152	210
315	223	84
51	252	30
335	173	197
278	192	423
222	110	46
189	109	40
138	346	385
67	45	44
32	59	51
63	230	179
56	35	27
206	431	118
327	100	136
122	94	111
90	228	50
210	102	218
91	136	41
29	146	206
230	94	27
65	27	32
110	413	225
380	157	165
736	140	27
654	146	439
95	383	26
301	55	223
52	312	194
26	64	157
199	72	260
104	262	44
94	83	261
226	88	100
246	59	295
95	65	29
357	367	258
413	254	37
54	26	48
34	70	72

96	80	72
234	351	141
363	221	32
57	269	302
562	283	43
140	115	55
329	66	205
76	104	37
102	242	25
363	89	382
421	65	171
87	108	37
276	94	1038
46	124	176
26	40	309
300	51	156
152	63	50
153	35	27
189	133	127
416	623	181
466	75	84
95	300	95
323	85	61
133	73	50
68	66	95
30	71	150
54	31	250
67	106	370
41	24	31
37	272	295
180	101	79
345	46	151
86	90	89
44	30	29
53	193	131
78	186	181
239	206	108
258	110	57

Diabetic subject #1 at 127 mg/dL glucose level

267	293	9
500	66	571
541	453	379
524	817	179
499	80	88
438	28	240
72	773	70
353	37	26
172	107	214
104	460	135
415	482	438
111	454	371
210	466	255
318	535	131
124	414	185
395	733	215
69	134	111
386	53	106
76	41	138
102	201	349
285	60	141
147	85	86
435	32	29
103	123	245
560	89	129
366	82	153
148	38	80
28	160	50
327	167	129
125	55	409
94	137	133
862	487	424
143	182	269
76	157	95
238	64	647
275	134	149
324	87	236
200	131	239
512	286	83
104	111	136
358	37	157
75	287	164
303	139	141
201	146	241
428	110	265

78	55	194
511	108	351
429	233	99
89	36	482
824	91	77
194	102	104
162	238	190
133	136	69
130	182	193
101	149	52
79	879	74
434	686	365
511	36	106
331	36	93
32	185	65
281	222	489
70	80	297
67	54	65
410	42	191
55	313	239
400	42	213
234	178	135
160	118	258
47	189	46
165	90	124
40	59	31
349	27	26
24	84	155
792	112	296
45	89	138
197	298	51
31	388	49
76	101	115
66	216	235
350	74	441
65	97	126
46	92	112
74	82	257
86	153	273
89	870	372
45	319	89
54	66	371
55	118	286
128	26	122
215	45	31
293	172	312
87	52	131

66	73	329
94	395	27
327	122	533
105	229	136
298	51	726
123	123	77
138	88	131
172	104	210
101	228	51
334	346	34
71	109	111
41	37	27
50	32	99
89	59	391
102	140	149
88	31	239
156	267	165
112	163	112
168	397	64
159	154	45
184	76	36
37	88	184
334	243	95
38	95	59
59	129	33
51	206	93
84	94	252
108	219	259
51	39	78
31	92	236
52	136	196
127	160	286
72	114	558
86	36	30
103	161	189
265	25	31
37	522	187
262	33	431
49	202	25
63	28	77
47	143	326
50	275	98
37	39	112
66	81	200
84	195	44
38	149	77
42	40	105

56	294	291
65	43	769
120	174	78
46	130	90
75	102	81
27	89	57
103	46	49
37	35	184
391	54	256
141	29	91
109	216	323
426	62	47
166	217	188
97	67	186
681	97	170
312	118	60
187	39	90
65	29	76
47	676	184
47	207	242
71	28	96
209	133	84
52	180	49
146	282	27
41	62	279
78	105	35
192	78	78
159	206	196
47	34	70
45	50	144
207	317	67
267	113	50
289	40	140
132	175	76
148	73	36
55	53	352
193	85	580
101	52	52
360	269	110
53	52	265
711	57	326
109	34	217
103	141	108
439	96	260
66	30	452
66	35	288
32	121	103

260	178	50
42	122	162
61	53	606
46	50	116
294	392	67
276	54	211
291	59	55
68	57	304
275	65	221
26	30	439
72	39	418
225	35	279
122	63	174
765	37	350
76	62	337
265	183	242
142	227	608
32	324	149
282	43	82
56	138	143
232	67	105
364	83	114
377	103	147
91	91	335
380	61	468
35	152	329
50	185	111
139	72	142
369	38	230
309	92	448
185	75	303
491	283	130
962	384	315
170	43	125
229	451	89
34	401	140
140	365	60
338	585	170
65	359	159
488	440	53
527	78	199
338	214	34
224	44	192
405	107	219
167	458	227
90	235	126
70	218	57

144	77	186
38	351	66
504	29	116
369	423	147
128	28	252
491	258	54
129	184	37
366	379	324
44	249	113
366	169	67
85	101	191
490	439	169
206	420	235
117	443	234
75	76	435
93	142	436
120	420	475
376	46	214
481	154	52
488	396	112
491	78	45
405	28	28
31	98	1700
65	235	322
252	308	200
70	83	128
183	345	34
222	140	370
395	215	222
42	50	237
246	150	66
491	395	322
173	29	88
613	301	45
42	81	271
41	148	87
506	94	100
30	265	77
707	687	91
154	435	53
41	76	146
140	225	33
183	450	147
208	405	190
124	41	84
93	362	412
112	397	86

55	43	293
259	257	66
60	78	453
186	76	817
64	88	80
314	334	28
88	314	773
58	158	37
24	82	107
156	259	460
331	221	482
76	115	454
531	474	466
40	66	535
88	346	414
642	195	733
100	188	134
36	31	53
901	32	41
99	193	201
30	131	60
148	153	85
364	112	32
42	224	123
476	897	89
86	427	82
894	343	38
49	53	160
296	45	167
403	321	55
363	300	137
127	850	487
267	52	182
433	123	157
178	225	64
293	47	134
112	237	87
68	288	131
58	43	286
331	59	111
43	148	37
284	603	287
396	70	139
93	46	146
167	170	110
183	67	55
276	63	108

69	65	233
69	89	36
99	60	91
112	146	102
77	28	238
506	30	136
41	86	182
275	50	149
44	132	879
42	34	686
92	184	36
267	40	36
181	89	185
706	90	222
383	124	80
31	48	54
306	81	42
799	215	313
164	24	42
476	59	147
83	84	2829
143	120	66
29	76	640
199	200	349
344	115	110
437	156	37
185	43	462
525	77	33
517	106	334
206	377	35
295	292	28
216	95	28
100	62	238
223	179	175
548	26	39
543	32	234
169	72	325
311	308	63
74	76	277
150	48	147
389	31	69
981	388	43
69	101	43
198	217	47
318	285	351
156	141	63
504	63	47

29	52	48
90	101	135
258	177	43
325	143	37
178	319	123
101	112	89
30	52	308
99	313	63
157	73	37
205	234	192
65	270	100
883	336	40
133	110	924
44	249	199
393	438	171
57	98	226
492	264	95
575	97	160
611	138	480
128	28	34
142	109	31
59	129	65
574	316	592
42	299	324
53	31	934
95	28	27
184	56	236
417	157	47
105	45	163
963	96	52
88	289	241
528	74	36
206	208	70
238	190	68
88	66	190
489	132	39
48	121	69
354	92	44
155	208	309
306	174	45
535	90	144
190	365	596
104	35	40
525	189	915
336	25	113
172	39	46
528	458	62

534	46	32
536	310	87
552	176	128
534	49	73
506	83	115
106	64	38
506	344	67
504	52	56
432	147	48
77	153	41
334	477	256
174	736	238
433	97	47
77	242	125
516	579	447
497	67	36
181	356	160
327	484	539
530	79	107
203	299	47
147	68	313
61	63	406
183	32	43
150	86	249
120	293	432
517	45	74
39	36	353
380	625	643
163	218	329
37	84	48
323	169	52
458	221	696
221	65	354
775	370	76
321	169	70
30	272	31
238	75	28
383	344	99
102	80	54
561	245	135
889	294	114
741	107	87
27	55	62
659	31	191
833	87	28
649	87	24
98	357	764

33	76	599
180	29	211
26	32	56
230	105	57
154	45	142
32	438	137
225	24	53
176	36	198
52	162	127
425	131	79
177	49	56
110	70	208
106	234	95
43	39	143
266	672	51
98	25	308
41	306	55
398	200	42
1047	37	76
201	673	163
237	776	50
445	33	149
863	141	62
188	46	50
885	27	45
262	997	44
252	51	111
119	280	178
239	394	46
924	46	66
168	268	38
40	163	28
142	413	100
778	87	46
963	67	109
375	567	173
280	121	46
211	142	34
336	140	33
163	48	95
378	857	88
137	196	39
527	157	35
539	995	203
529	454	68
379	81	27
78	264	243

75	42	26
202	52	338
312	215	62
512	66	167
423	146	140
78	136	73
501	155	254
101	52	182
336	41	179
376	56	85
343	56	56
345	162	72
61	461	40
59	359	243
218	62	35
49	80	119
54	43	41
972	218	181
40	37	388
267	487	498
47	45	402
48	36	40
56	300	60
225	236	291
25	39	28
76	67	383
35	34	156
155	64	29
421	29	260
254	216	35
157	166	69
73	29	621
199	316	252
40	352	96
163	39	44
185	288	442
152	211	78
202	35	123
293	162	151
134	46	65
297	28	35
427	41	51
261	67	58
160	62	29

Diabetic subject #2 at 168 mg/dL glucose level

39	213	126
164	81	337
280	192	479
68	34	463
122	119	399
77	41	433
33	188	115
502	435	358
46	85	74
106	507	76
30	432	85
209	73	399
120	467	497
78	196	418
257	77	72
219	38	925
72	347	461
220	110	491
345	363	518
81	93	530
60	107	100
30	213	137
351	269	202
375	53	75
526	89	415
33	200	649
60	126	523
260	77	539
745	324	1073
659	486	450
507	514	84
52	65	538
703	252	533
275	139	508
144	123	509
222	50	513
32	322	437
65	100	72
84	105	423
168	803	74
581	295	460
67	40	24
209	303	475
89	144	497
203	73	434

560	79	73
467	168	500
733	39	504
289	48	521
27	43	532
42	64	528
356	69	501
46	917	448
56	200	76
77	427	519
63	27	399
48	73	106
130	545	525
160	33	530
24	784	529
449	350	854
484	723	175
393	494	517
51	561	510
84	844	415
182	424	74
27	147	495
871	43	25
29	559	114
213	223	387
129	53	517
281	231	151
88	50	255
177	165	86
231	118	524
46	719	525
472	149	531
39	47	500
350	231	535
36	918	546
27	115	514
987	238	101
874	241	416
557	469	524
179	338	394
989	110	47
252	263	77
918	36	510
36	277	83
320	851	431
27	46	499
148	30	89

35	130	300
51	351	86
64	57	94
25	149	66
49	133	245
46	40	63
48	1259	267
35	500	240
56	37	474
98	264	54
698	57	543
78	44	548
322	79	557
56	43	531
76	273	543
30	37	552
157	40	553
332	543	540
39	735	544
33	266	557
29	460	565
52	501	469
218	54	80
134	210	560
280	96	310
164	25	258
44	54	550
137	54	531
236	152	530
179	998	535
198	96	551
208	344	470
171	119	74
52	100	387
431	514	157
334	522	552
378	512	518
120	70	71
47	349	397
299	80	72
64	306	474
45	194	557
46	443	60
91	61	171
105	516	43
34	89	149
44	114	38

238	230	25
101	236	322
104	123	87
521	73	174
41	64	150
306	114	34
102	61	79
439	42	216
130	35	34
61	130	167
201	152	49
79	264	71
205	141	277
399	445	503
357	53	518
207	234	537
447	373	677
75	159	388
468	93	57
76	153	38
367	168	65
186	95	177
490	50	87
50	421	55
32	77	416
215	405	313
118	89	142
187	35	42
180	511	71
62	227	54
49	298	153
193	121	200
27	324	269
243	89	58
245	251	68
67	28	204
61	98	86
153	151	44
72	85	52
459	423	43
289	490	97
76	26	45
187	155	83
67	208	226
32	166	492
112	551	282
28	552	224

36	512	943
62	34	71
515	514	532
36	561	538
64	519	539
64	459	555
42	74	488
169	505	75
53	510	545
76	524	519
75	395	508
72	148	513
101	395	532
200	62	407
58	76	117
43	501	512
48	507	529
35	532	529
318	345	521
136	190	259
77	446	249
219	73	523
52	500	541
189	514	511
73	515	449
175	451	76
43	73	531
489	507	342
157	279	281
69	238	418
123	367	535
58	163	548
114	520	525
175	500	512
827	508	455
457	943	72
59	76	542
479	113	519
481	359	509
261	438	528
32	73	525
146	104	506
66	326	521
466	194	537
102	529	530
804	524	501
138	515	275

61	523	229
38	537	388
54	523	138
387	522	257
37	109	282
123	542	535
687	528	531
34	543	510
377	433	510
66	118	527
703	542	534
235	508	527
41	517	531
984	523	548
160	496	1062
286	481	531
819	495	252
55	351	149
36	152	48
457	418	79
585	88	400
796	485	198
85	370	171
361	140	337
53	445	68
571	76	479
147	472	49
71	41	87
221	506	268
183	104	63
47	332	295
56	174	223
112	488	60
737	495	95
335	505	30
42	427	51
88	75	151
201	492	124
66	518	42
123	160	160
41	865	74
67	652	80
581	366	61
202	504	96
148	353	203
133	136	125
398	250	31

149	220	32
408	43	151
353	500	156
405	496	28
35	490	74
164	23	85
116	514	155
34	531	49
44	170	184
53	352	124
186	150	352
307	334	26
33	53	114
217	467	34
126	76	161
59	547	395
120	343	74
210	139	793
47	65	367
68	52	34
242	213	239
696	143	66
648	211	110
702	458	87
768	516	81
304	295	62
149	70	76
55	86	62
140	41	585
285	55	361
284	49	105
38	110	151
488	37	160
35	29	68
69	48	193
709	201	169
34	159	35
136	252	272
472	154	232
960	336	83
42	26	371
618	228	174
38	768	37
65	139	66
512	49	32
35	73	37
466	220	112

148	644	49
271	502	37
100	116	232
97	118	68
646	49	41
144	33	66
38	277	267
59	78	248
80	212	295
31	25	729
64	388	48
64	288	214
171	35	396
103	189	214
423	410	662
42	236	113
34	168	54
244	83	55
79	804	985
106	236	108
209	71	550
61	163	59
37	280	53
110	68	876
89	99	226
99	56	751
52	62	75
25	73	484
175	395	507
109	58	513
106	288	451
78	175	77
144	34	522
51	30	105
45	135	481
34	61	71
661	61	549
467	417	524
39	44	516
281	160	526
69	342	544
46	451	467
412	31	71
27	111	523
341	38	538
150	30	387
185	96	164

390	288	560
390	59	126
203	144	78
48	128	274
227	177	52
68	266	238
48	157	223
254	86	79
558	52	599
59	31	27
197	98	313
87	124	486
66	93	109
51	747	48
719	281	450
472	442	43
486	65	49
498	198	49
515	29	152
431	41	54
77	703	297
510	71	67
614	524	416
163	593	37
35	62	539
76	441	524
45	145	506
338	136	527
121	58	539
178	108	475
331	39	71
49	33	537
43	865	551
353	410	381
47	542	174
32	31	103
72	550	167
75	422	52
52	242	56
113	508	74
55	994	158
57	136	112
37	87	318
142	44	301
129	59	110
118	358	79
50	154	73

76	175	249
335	139	286
215	117	435
210	43	141
144	180	295
67	61	221
476	61	269
153	92	883
53	58	201
57	40	320
86	70	510
274	64	518
113	136	533
39	37	528
257	80	522
73	39	533
123	41	539
134	73	536
418	140	529
350	65	546
39	77	557
107	51	575
118	34	535
110	33	562
69	130	552
72	128	418
57	129	144
954	36	539
63	379	541
35	117	464
452	506	80
188	345	104
161	239	527
200	223	544
62	216	536
299	65	544
125	119	159
144	177	79
320	25	160
477	608	152
29	228	539
73	35	529
784	224	344
605	221	198
369	503	479
27	26	73
65	27	534

60	38	521
299	27	540
26	171	534
86	335	514
147	632	312
223	184	194
44	111	519
46	103	1086
99	629	386
177	680	88
42	2854	73
175	904	533
63	60	511
141	456	512
45	117	504
211	117	486
63	254	498
36	292	373
252	131	146
137	37	542
109	36	541
205	134	542
335	119	484
70	173	75
72	129	488
375	77	76
26	232	558
35	436	544
430	434	
79	189	
88	243	

Diabetic subject #2 at 234 mg/dL glucose level

77	56	90
658	317	128
161	244	42
71	113	152
410	57	188
83	181	396
133	126	138
296	60	62
50	45	452
154	134	745
118	125	75
342	344	362
85	96	76
358	110	455
74	399	467
441	232	458
666	246	381
163	259	455
394	40	452
208	138	73
99	198	366
215	35	73
288	144	434
139	40	351
251	72	497
92	295	342
73	57	71
151	176	325
187	135	94
77	79	420
273	41	348
44	218	72
96	50	415
340	138	409
70	476	160
406	149	75
324	589	351
395	157	33
65	36	41
315	54	435
86	108	309
202	445	118
103	399	361
93	416	75
637	43	245

64	322	45
816	31	214
39	188	242
242	162	321
179	281	482
165	213	73
45	49	409
182	89	409
31	170	419
48	43	422
228	90	347
107	47	72
51	73	412
74	166	347
57	38	74
132	180	307
70	102	36
46	112	246
39	422	25
390	80	285
446	119	989
386	270	847
303	141	141
170	100	593
197	327	235
199	66	24
581	58	44
148	163	41
162	63	29
95	61	246
326	162	23
498	74	69
324	96	36
394	204	72
97	31	252
329	38	380
73	61	108
208	308	212
88	112	95
27	217	50
78	92	146
304	111	106
203	180	26
571	56	53
116	77	119
271	106	40
991	59	62

175	242	43
312	32	157
487	56	43
245	28	226
257	118	80
114	219	67
245	74	403
277	132	426
32	177	25
230	49	67
107	192	74
398	181	63
327	371	187
75	66	90
413	352	177
432	57	68
444	87	158
451	304	262
446	27	194
447	243	51
368	175	145
75	247	376
432	56	156
346	236	292
74	185	36
101	78	161
172	60	147
73	387	187
340	50	32
822	50	201
490	304	73
781	504	58
497	402	30
323	27	26
94	267	122
414	76	258
608	86	320
208	425	70
329	67	54
70	273	38
336	456	73
74	35	858
346	129	106
74	63	41
426	117	44
442	176	298
349	31	179

75	74	1550
349	88	393
75	57	451
133	302	159
293	328	423
426	92	151
429	61	103
336	42	262
175	192	254
105	187	65
74	285	325
174	124	104
256	33	386
61	41	182
37	200	182
30	81	43
174	136	457
48	273	41
25	46	58
29	49	94
325	208	56
470	53	56
112	148	31
309	342	266
136	144	196
77	61	36
86	89	54
71	195	52
156	302	342
121	217	34
2105	361	203
342	75	439
115	110	58
335	37	467
73	85	239
428	60	35
328	44	27
93	38	125
422	67	396
348	277	326
284	93	150
142	173	365
398	345	33
67	84	373
25	270	90
414	24	61
276	300	47

51	136	34
272	413	419
57	243	27
52	189	368
110	104	44
87	56	24
41	360	159
195	756	38
83	77	26
149	324	101
171	210	264
79	67	38
125	174	75
128	75	1556
216	357	124
237	76	58
88	360	50
415	291	158
339	145	217
153	156	57
36	352	155
229	345	158
44	75	32
29	317	233
326	94	165
102	339	270
89	73	398
115	409	49
596	685	748
821	36	1037
74	70	403
357	116	364
426	247	154
234	207	162
186	149	175
73	31	579
68	415	195
344	219	51
96	630	139
149	380	44
455	204	181
431	240	34
297	100	32
62	185	643
451	117	60
74	185	99
164	110	72

152	183	101
93	325	2919
342	40	216
378	64	44
79	76	480
46	175	68
119	149	570
39	388	68
58	236	39
263	74	103
42	138	347
81	205	142
57	141	72
100	191	166
171	193	45
125	78	47
69	44	80
92	95	229
31	88	155
359	103	444
304	129	53
105	68	360
276	38	131
157	219	33
228	98	138
114	319	40
56	114	64
463	398	54
49	81	30
43	334	65
77	75	35
35	634	382
96	155	308
111	379	54
1172	68	216
402	132	60
108	191	107
352	199	45
436	212	275
76	184	46
355	320	94
429	307	58
195	98	399
298	125	432
430	65	141
362	157	58
75	159	62

433	253	128
426	909	442
346	347	94
76	425	187
429	432	32
431	75	40
431	413	39
348	425	44
76	329	164
434	95	179
358	346	135
442	75	250
502	665	54
765	507	119
74	78	131
342	759	85
75	77	37
342	345	245
74	266	48
416	234	39
308	346	136
283	412	271
62	76	39
106	322	585
297	430	121
121	228	131
290	63	53
154	181	167
47	375	30
107	267	64
220	493	46
359	399	103
263	28	48
252	75	62
62	331	63
873	149	132
376	52	34
505	198	104
552	169	157
373	238	628
236	106	147
32	531	86
75	136	263
261	83	243
45	433	167
41	419	152
238	43	81

163	28	232
97	94	167
84	52	60
230	121	174
53	73	86
47	49	23
66	495	262
267	124	88
279	71	465
237	65	304
421	349	110
84	237	274
267	43	320
256	140	72
250	36	333
362	186	73
74	948	340
143	80	504
89	79	352
281	253	73
83	76	772
281	337	73
351	427	345
538	29	72
622	44	345
192	697	73
315	60	317
44	111	91
74	279	327
179	67	72
257	865	389
50	418	380
25	74	314
356	347	294
83	421	163
238	73	395
213	346	508
663	74	60
582	348	34
74	52	79
378	28	26
76	412	37
809	411	66
439	337	217
81	75	201
368	256	195
76	154	340

783	345	294
73	74	100
258	320	216
452	91	636
41	332	73
295	33	324
162	42	86
76	405	335
352	409	155
516	780	27
376	519	22
73	369	343
381	76	326
75	368	151
161	75	93
198	808	510
51	75	129
46	430	98
47	356	96
146	501	28
189	78	562
51	132	68
31	126	492
175	342	30
37	27	36
133	305	180
77	222	39
245	118	121
65	51	86
24	118	28
87	100	281
237	53	107
110	248	515
133	95	42
740	67	49
404	654	138
325	71	261
176	312	48
44	92	129
41	215	47
96	50	128
420	34	212
83	280	56
62	63	113
268	116	289
72	76	62
334	183	74

73	148	310
409	51	54
285	391	39
51	340	45
485	88	205
417	310	447
349	59	56
848	63	499
928	74	1657
355	204	57
74	60	102
431	82	65
434	73	47
352	295	72
74	41	101
194	423	191
91	73	1979
40	345	72
47	417	242
42	170	74
121	71	535
140	153	582
48	62	30
179	263	250
71	95	169
32	258	363
193	177	271
31	64	364
58	301	156
39	29	44
316	76	259
163	56	38
114	44	334
54	80	235
88	138	439
71	82	387
36	191	361
131	135	414
101	193	546
215	109	252
171	278	38
102	250	59
218	142	867
132	206	35
67	99	199
100	128	57
152	44	3

63	164
60	71
30	89
280	175
60	78
286	215
133	273

Diabetic subject #3 at 136 mg/dL glucose level

54	312	101
71	330	423
175	121	42
238	542	34
479	431	244
915	143	79
73	53	106
499	79	209
314	131	61
92	122	37
97	49	110
440	167	89
73	258	99
364	47	52
26	50	25
49	343	175
90	46	109
327	150	106
361	178	78
89	35	144
101	31	51
67	133	45
77	35	34
83	32	661
157	468	467
122	398	39
83	158	281
63	179	69
67	168	46
227	321	412
210	66	27
154	156	341
35	86	150
388	140	185
39	420	390
47	81	390
89	43	203
126	37	48
283	231	227
151	305	68
24	49	48
118	140	254
63	81	558
240	27	59
90	56	197

31	202	87
76	801	66
32	93	51
39	30	719
344	170	472
64	162	486
149	78	498
88	30	515
38	48	431
154	39	77
57	95	510
146	50	614
306	152	163
63	199	35
45	92	76
88	37	45
53	74	338
68	280	121
29	54	178
43	525	331
44	108	49
162	36	43
55	120	353
80	72	47
134	138	32
166	76	72
124	256	75
62	581	52
108	374	113
80	35	55
130	77	57
64	153	37
40	129	142
125	367	129
50	160	118
147	147	50
341	27	76
167	104	335
92	508	215
67	49	210
223	58	144
126	700	67
35	375	476
316	152	153
45	200	53
360	75	57
158	129	86

80	37	274
150	505	113
186	242	39
163	507	257
127	44	73
119	35	123
39	46	134
65	960	418
49	122	350
183	493	39
48	992	107
467	90	118
90	911	110
28	449	69
266	277	72
63	45	57
262	57	954
50	305	63
25	50	35
44	188	452
39	329	188
48	886	161
53	39	200
78	68	62
180	58	299
269	74	125
302	52	144
45	183	320
40	74	477
48	155	29
162	112	73
126	93	784
31	170	605
277	46	369
75	29	27
153	43	65
876	295	60
151	100	299
264	46	26
26	324	86
42	65	147
24	171	223
489	36	44
161	488	46
291	53	99
42	507	177
143	353	42

34	200	175
46	151	63
207	364	141
72	160	45
40	399	211
277	89	63
889	58	36
220	914	252
323	45	137
42	67	109
404	65	205
169	50	335
50	151	70
51	425	72
32	29	375
35	52	26
251	35	35
299	65	430
170	28	79
313	234	88
91	61	213
122	37	81
56	530	192
122	686	34
33	54	119
44	205	41
83	285	188
344	36	435
87	332	85
64	63	507
85	55	432
55	63	73
258	30	467
29	38	196
126	42	77
42	52	38
788	59	347
45	34	110
43	48	363
57	38	93
470	28	107
369	31	213
72	369	269
220	94	53
61	146	89
118	270	200
110	488	126

85	250	77
194	53	324
79	58	486
63	103	514
45	47	65
182	181	252
56	56	139
71	32	123
459	167	50
158	26	322
55	99	100
27	334	105
937	193	803
974	898	295
962	25	40
835	194	303
118	296	144
256	27	73
387	433	79
648	874	168
238	482	39
195	45	48
293	148	43
49	54	64
111	70	69
440	51	917
193	60	200
104	30	427
31	73	27
79	53	73
127	38	545
197	61	33
47	48	784
387	231	350
202	43	723
658	157	494
195	24	561
51	395	844
47	34	424
281	169	147
798	159	43
105	41	559
507	223	223
24	254	53
536	339	231
155	99	50
179	38	165

112	156	118
675	60	719
207	349	149
590	32	47
215	52	231
178	42	918
302	352	115
114	45	238
530	358	241
146	262	469
195	446	338
388	41	110
271	334	263
375	36	36
374	344	277
27	133	851
150	429	46
322	46	30
122	156	130
43	551	351
35	286	57
194	36	149
27	50	133
48	59	40
37	66	125
120	281	500
247	111	37
47	39	264
66	164	57
73	280	44
30	68	79
74	122	43
40	77	273
55	33	37
79	502	40
377	46	543
38	106	735
79	30	266
74	209	460
617	120	501
50	78	54
42	257	210
40	219	96
51	72	25
45	220	54
217	345	54
40	81	152

335	60	998
283	30	96
41	351	344
41	375	119
41	526	100
345	33	514
352	60	522
105	260	512
146	745	70
130	659	349
180	150	80
52	52	306
26	703	194
267	275	443
42	144	61
130	222	516
112	32	89
168	65	114
46	84	230
140	168	236
51	581	123
125	67	73
456	209	64
173	89	114
53	203	61
65	560	42
57	467	35
68	733	130
147	289	152
122	27	264
219	42	141
83	356	445
503	46	53
60	56	234
40	77	373
58	63	159
41	48	93
32	130	153
81	160	168
52	24	95
34	449	50
60	484	421
513	393	77
51	51	405
312	84	89
594	182	35
39	27	511

26	871	227
410	29	298
54	213	121
29	129	324
459	281	89
953	88	251
45	177	28
35	231	98
56	46	151
51	472	85
122	39	423
356	350	490
213	36	26
70	27	155
46	987	208
147	874	166
32	557	551
487	179	552
239	989	512
197	252	34
37	918	514
248	36	561
291	320	519
173	27	459
29	148	74
493	35	505
372	51	510
96	64	524
57	25	395
126	49	148
62	46	395
525	48	62
50	35	76
24	56	501
48	98	507
35	698	532
306	78	345
54	322	190
49	56	446
36	76	73
58	30	500
258	157	514
38	332	515
672	39	451
258	33	73
51	29	507
50	52	279

204	218	238
52	134	367
55	280	163
209	164	520
43	44	500
280	137	508
37	236	943
492	179	76
60	198	113
36	208	359
56	171	438
109	52	73
241	431	101
130	334	326
151	137	194
237	120	529
62	47	524
26	299	515
115	64	523
489	45	537
36	46	523
36	91	522
54	105	109
592	34	542
93	44	528
55	238	543
100	101	433
38	104	118
156	252	542
38	41	508
55	370	517
226	102	523
54	439	496
40	130	481
302	61	495
258	201	351
201	79	152
57	205	418
41	399	88
145	357	485
53	207	370
39	447	140
77	75	445
28	468	76
69	76	472
40	367	41
330	186	506

229	490	1042
71	50	332
45	32	174
41	215	488
75	118	495
179	187	505
150	180	427
69	62	75
221	49	492
218	193	518
337	27	160
85	243	865
810	245	652
28	67	366
61	61	504
662	153	353
35	72	136
29	459	250
76	289	220
486	76	43
86	187	500
26	67	496
45	32	490
206	112	23
76	28	514
59	36	531
59	62	170
127	515	352
410	36	150
32	64	334
44	64	53
34	42	467
233	169	76
27	53	547
138	76	343
33	75	139
241	72	65
202	101	52
26	200	213
483	58	143
213	43	211
279	48	458
633	35	516
270	318	295
37	136	70
155	77	86
92	219	41

42	52	55
31	189	49
44	73	110
263	175	37
66	43	29
26	489	48
73	157	201
41	69	159
29	123	252
473	58	154
409	114	336
389	175	26
187	827	228
50	457	768
159	59	163
99	479	49
451	481	73
196	261	220
261	32	644
162	146	502
50	66	116
85	466	119
28	102	49
66	804	33
230	138	277
121	61	78
47	38	212
96	54	25
50	387	388
72	37	288
995	123	35
270	687	189
56	34	410
505	377	236
45	66	168
62	703	83
526	235	804
524	41	236
335	984	71
134	160	163
49	122	28
418	819	102
102	55	68
715	36	99
24	457	56
124	585	62
25	779	73

84	85	395
90	361	58
104	53	128
85	571	175
372	147	34
825	71	30
544	221	135
45	183	61
306	47	61
543	56	417
154	112	44
681	737	160
275	335	342
491	42	451
322	88	31
60	201	111
110	66	38
610	123	30
144	41	96
82	67	288
364	581	59
105	202	144
46	148	128
225	133	177
144	398	266
376	149	157
772	408	86
251	353	52
133	405	31
801	35	98
194	164	120
170	116	93
234	34	747
701	44	281
201	53	442
75	148	65
47	307	198
274	33	29
58	217	41
54	126	703
105	59	71
308	120	524
38	210	593
134	47	62
324	68	441
103	242	145
140	696	136

111	648	58
177	702	108
243	768	39
437	349	33
54	149	865
147	55	410
147	140	542
81	285	31
289	284	550
155	38	422
65	488	227
179	35	508
53	69	994
52	709	136
529	34	87
485	136	44
115	472	59
397	960	358
131	42	154
73	618	175
246	38	139
42	65	117
484	512	43
416	35	180
348	466	61
220	148	61
489	271	92
499	100	58
290	97	40
696	646	70
311	144	64
29	38	136
146	59	37
401	800	80
276	31	39
92	64	41
73	64	73
680	171	140

Diabetic subject #3 at 222 mg/dL glucose level

501	309	299
48	113	126
159	424	286
535	62	71
46	354	62
85	423	149
49	439	283
37	438	208
173	359	34
37	71	64
66	355	31
52	84	73
71	438	99
154	446	678
64	432	152
234	438	165
578	441	154
26	440	348
71	423	74
400	110	355
193	156	178
281	421	42
100	229	33
321	183	153
204	198	26
191	210	280
57	417	195
25	423	25
110	352	272
75	78	34
148	425	44
67	737	38
25	50	193
166	89	207
34	435	94
123	772	210
34	78	91
72	407	168
162	406	48
478	800	123
211	43	328
64	404	42
169	251	71
181	163	281
29	955	125

323	305	267
99	416	133
42	290	478
157	95	270
32	33	90
26	441	75
186	870	212
54	340	30
302	414	35
736	79	63
27	143	119
47	367	201
168	293	111
56	74	418
31	434	285
243	275	472
377	343	68
61	47	340
94	394	72
108	833	207
96	370	193
54	73	95
366	312	191
39	157	29
220	471	120
36	382	63
32	74	247
64	367	129
51	73	250
28	204	201
219	233	207
29	447	167
43	442	73
315	60	324
28	314	499
81	78	39
75	77	350
47	135	36
37	659	67
49	189	55
306	74	84
39	166	278
88	381	65
204	29	61
43	158	78
29	203	65
153	51	147

33	37	140
40	62	50
153	56	388
43	265	306
193	47	95
466	45	54
121	134	58
406	249	45
691	132	33
216	81	47
190	34	41
163	262	72
95	161	326
482	51	60
337	49	68
88	40	122
433	33	62
332	186	37
345	36	71
208	423	77
184	406	52
235	301	219
23	128	212
426	242	56
147	82	470
167	72	52
201	38	33
48	40	143
165	68	46
101	207	55
129	267	110
277	297	311
195	539	55
128	33	259
26	532	678
256	148	187
62	330	43
379	41	70
42	29	51
165	48	206
275	109	32
57	87	93
31	137	142
66	37	139
153	326	55
181	76	428
108	801	38

67	400	163
29	93	162
47	266	66
55	34	114
100	389	50
145	397	55
142	405	157
105	262	30
37	151	138
44	244	95
197	171	38
189	426	230
153	426	66
40	435	137
153	423	35
382	408	143
636	414	109
58	421	279
41	369	32
46	62	384
426	151	114
207	181	211
89	107	129
113	98	132
216	581	219
313	268	273
192	316	122
59	207	27
71	477	60
93	144	137
32	260	32
210	62	559
187	204	1544
422	76	840
231	53	182
149	174	120
44	37	757
61	365	25
53	231	112
389	207	52
86	450	320
37	118	224
47	195	29
57	170	61
51	76	307
62	150	574
153	250	136

63	395	334
149	412	967
451	131	59
99	280	32
76	421	161
269	415	136
99	142	298
220	522	679
141	145	68
309	792	773
460	31	313
121	333	33
189	218	59
52	123	864
492	108	135
128	167	292
711	104	470
55	167	213
131	65	772
260	190	91
42	249	1214
155	172	1046
34	83	520
36	63	175
56	176	271
98	48	25
47	84	449
128	324	32
322	204	24
64	56	170
85	55	790
116	86	137
40	48	168
202	54	767
31	32	839
60	49	234
35	221	603
771	124	850
99	163	149
111	35	266
76	270	878
56	37	347
224	106	34
97	153	108
33	760	49
714	190	537
138	60	949

62	202	137
54	55	112
59	26	114
38	488	320
246	78	28
94	241	959
25	45	113
145	750	115
34	157	120
135	99	143
108	55	229
30	132	107
52	262	367
603	363	318
143	251	671
87	30	25
142	64	723
286	41	632
138	129	136
81	210	36
197	71	77
295	150	92
122	257	25
87	269	584
172	969	44
301	144	152
74	32	196
38	248	2152
36	70	61
48	342	243
160	52	258
27	453	41
618	201	39
203	140	549
55	237	235
91	27	687
33	60	126
50	30	281
226	148	129
43	194	267
50	137	150
190	54	425
49	560	31
28	334	616
68	75	859
289	63	85
78	140	42

446	27	53
156	87	80
720	147	196
417	59	160
277	77	50
406	200	159
33	51	151
125	115	3456
582	73	185
51	63	52
405	77	424
42	57	176
288	54	197
591	346	799
135	43	106
271	395	29
511	53	194
370	841	59
71	28	54
90	32	46
772	28	40
95	586	298
445	46	198
446	239	244
444	68	219
192	32	798
62	613	464
37	57	516
134	57	53
78	123	263
56	87	179
133	43	170
31	66	862
67	396	155
138	48	236
38	970	2123
106	43	58
85	509	122
31	336	127
30	56	78
44	54	260
37	166	523
295	230	47
335	167	49
149	390	395
35	48	35
172	363	1462

176	322	54
619	481	434
113	149	916
171	280	28
42	40	29
115	96	46
36	399	59
163	211	31
257	97	58
35	890	285
251	39	790
209	62	144
194	96	29
224	242	117
434	29	356
445	151	185
438	537	200
447	60	143
211	185	97
238	28	292
432	387	48
351	503	216
75	137	302
389	27	47
33	114	55
103	54	188
86	108	34
215	282	42
94	66	210
316	41	49
767	75	215
510	101	392
420	178	384
315	124	63
108	735	407
429	40	301
410	55	399
302	96	425
122	727	437
260	62	37
75	58	784
129	193	47
296	133	117
36	170	107
34	45	52
56	219	50
53	281	153

245	94	132
98	207	101
229	77	134
70	67	309
73	250	34
49	276	290
33	42	101
46	116	196
135	65	67
74	41	182
130	70	37
115	204	627
78	30	52
96	206	29
244	88	383
75	95	34
104	222	90
173	289	196
137	44	63
266	37	91
278	41	107
61	59	103
224	382	196
145	61	145
327	214	82
89	106	369
421	919	38
417	341	150
441	41	92
127	28	115
67	647	325
448	201	146
450	440	109
447	435	278
349	189	309
95	240	85
157	272	151
529	40	242
100	448	141
292	257	117
67	85	145
112	152	398
91	100	403
150	707	398
159	89	387
65	106	153
51	83	256

202	128	313
72	242	72
40	526	395
45	404	398
41	36	408
568	69	248
98	32	26
481	523	140
151	224	256
303	274	63
67	82	91
79	39	414
120	69	110
726	128	302
34	81	232
779	78	203
630	313	474
40	399	247
73	399	402
51	422	348
414	879	145
364	137	392
362	292	381
31	440	258
227	429	128
217	558	306
108	257	143
463	400	233
315	664	60
153	60	565
284	295	203
31	199	219
275	75	174
147	129	43
754	163	221
502	45	84
42	111	267
39	169	58
262	40	37
260	183	125
252	60	165
598	237	25
221	112	29
349	290	68
132	63	29
32	135	137
373	517	40

749	900	33
115	56	40
144	37	55
329	307	92
31	211	136
492	40	63
37	156	150
37	412	38
57	174	31
39	322	60
57	227	52
38	127	40
39	280	177
54	165	42
103	251	39
224	332	40
64	185	40
27	54	168
68	190	61
186	682	40
298	60	68
76	567	40
38	359	29
216	130	1
31	400	
138	595	
94	30	
258	128	
49	63	
61	199	
227	306	
284	32	
216	137	
71	42	
68	750	
171	108	
30	147	
313	259	
385	129	
626	570	
526	42	
852	601	
96	150	
294	935	
84	428	
34	37	
217	66	

73	33
734	59
326	28
35	82
112	29
54	189
207	183
110	29
37	38
165	707
512	362
290	423
31	113
99	71
263	75
54	256
49	39
36	309
65	31
30	36
192	4534
246	665
561	227
565	121
973	97
162	309
220	350
591	75
543	407
274	376
162	75
247	390
53	51
67	454
58	463
142	388
445	31
95	40
135	354
273	105
291	297
341	152
164	102
392	109
286	233
113	153
333	82

67	77
210	45
530	67
74	426
426	306
425	525
101	420
676	421
75	114
209	135
207	170
418	150
402	698
407	816
823	49
433	404
753	40
504	450
399	70
390	241
316	147
51	461
25	381
327	80
75	132
409	324
410	87
413	744
414	160
426	102
428	124
415	108
613	413
224	344
70	91
345	52
346	287
76	79

Diabetic subject #4 at 141 mg/dL glucose level

77	95	219
356	37	47
363	368	46
546	415	303
62	325	41
341	119	216
403	60	172
339	93	138
862	82	310
75	160	147
372	96	68
76	31	66
381	346	38
460	413	156
908	92	64
449	148	230
44	276	83
68	164	187
97	229	41
64	33	71
166	94	129
71	252	39
144	179	226
71	83	68
105	307	84
112	134	161
358	49	66
354	262	587
860	29	60
97	41	58
342	114	51
429	56	66
931	217	157
430	206	57
190	74	126
251	351	181
355	242	312
396	118	613
96	219	325
329	37	398
844	48	311
73	329	441
768	50	34
411	394	218
422	249	127

95	65	66
433	263	242
775	155	48
75	359	202
425	475	128
358	432	735
66	373	42
367	43	30
56	84	53
371	309	235
390	445	39
446	54	68
601	763	106
225	410	51
75	526	259
328	355	44
76	75	27
400	354	782
328	74	31
75	349	26
315	71	772
833	354	41
66	73	54
330	114	26
67	77	48
422	742	395
348	827	213
74	340	90
354	79	587
74	74	503
353	749	32
507	126	49
706	73	114
95	768	177
429	345	429
842	351	58
73	175	665
418	122	732
340	112	735
73	69	296
324	302	51
77	42	212
271	64	135
52	44	50
373	48	128
487	42	139
334	369	90

401	40	175
874	73	58
75	347	153
435	210	70
345	55	38
27	49	199
76	24	43
445	60	30
365	68	78
74	38	25
355	333	67
73	340	346
398	111	928
361	73	26
418	547	32
73	70	36
340	57	642
398	63	804
851	74	297
74	81	46
353	737	72
72	218	28
345	86	59
74	90	93
349	336	39
72	410	635
350	207	64
74	199	49
418	158	662
346	515	54
416	138	357
74	34	171
112	366	44
81	170	123
121	58	32
444	28	48
885	121	41
341	178	72
482	71	47
363	362	192
46	95	88
329	101	116
182	351	134
308	530	52
341	193	31
73	238	34
418	142	271

316	203	52
188	62	41
468	83	310
201	36	436
74	170	37
133	78	73
276	102	33
333	399	36
73	147	194
322	36	63
486	66	33
150	32	125
60	126	75
109	60	30
375	29	152
355	710	508
125	165	214
333	56	185
228	307	184
111	126	115
403	74	42
25	361	120
453	77	397
345	795	42
412	28	279
421	239	644
74	257	74
795	64	40
73	55	143
444	173	269
367	274	24
73	411	316
441	915	56
674	233	450
131	33	209
153	699	205
44	283	142
172	1575	179
30	65	82
393	55	48
70	235	38
300	53	224
96	62	79
213	565	174
77	58	31
404	80	171
74	102	80

91	53	690
275	36	60
311	205	44
384	25	79
248	85	485
221	253	275
711	305	70
82	42	35
340	374	184
73	30	214
341	953	291
73	32	169
331	246	213
93	361	63
347	34	61
73	134	61
746	41	613
72	224	37
389	575	154
738	163	489
476	149	55
407	164	31
324	357	26
94	80	77
688	207	307
910	70	52
74	69	165
323	266	210
32	101	64
277	78	220
304	42	701
33	137	408
258	184	69
149	270	233
44	100	78
57	134	116
69	210	208
138	98	78
74	188	317
93	106	267
139	117	700
286	222	162
33	232	26
81	292	201
107	87	244
72	74	55
361	306	28

189	79	96
342	84	139
55	31	134
73	218	458
64	249	58
185	194	454
378	105	363
352	136	67
394	173	44
55	66	205
104	272	40
56	51	51
347	95	110
162	47	79
596	50	142
197	41	46
88	68	239
58	171	66
302	843	449
75	65	180
686	53	159
30	459	150
130	264	98
60	113	49
172	171	159
50	46	54
39	57	48
29	317	28
129	37	50
260	316	56
194	70	235
312	109	368
194	86	386
131	54	175
870	62	37
75	43	40
65	100	119
289	87	307
75	73	209
352	101	139
74	129	115
939	25	166
241	93	32
92	206	140
355	118	258
409	59	92
104	317	112

378	99	75
65	64	266
367	63	70
71	33	55
206	339	37
224	57	113
324	151	38
366	66	457
98	134	25
60	84	115
792	84	35
50	95	48
359	168	141
437	59	41
879	224	409
83	63	834
444	46	134
365	58	51
222	55	53
284	42	61
354	26	39
54	27	54
95	126	223
262	108	220
93	403	89
357	152	79
274	32	810
145	33	466
542	151	32
352	24	139
465	101	276
76	37	75
369	159	187
75	378	61
371	50	168
75	35	64
362	60	418
425	207	143
409	220	60
482	45	27
319	32	94
281	106	120
154	148	78
363	54	49
129	41	32
913	80	293
276	36	37

73	41	56
352	51	1037
164	164	224
484	41	46
763	47	291
74	37	392
122	68	29
170	53	44
166	130	54
54	71	41
50	81	97
304	100	124
121	96	50
80	145	46
232	92	95
202	246	227
201	52	43
103	78	93
44	320	119
73	42	353
521	96	100
318	31	119
349	148	220
122	184	163
69	115	40
266	42	38
101	120	55
78	397	60
42	42	76
137	279	210
184	644	72
270	74	136
100	40	364
134	143	325
210	269	294
98	24	56
188	316	72
106	56	64
117	450	292
222	209	36
232	205	186
292	142	51
87	179	157
74	82	78
306	48	53
79	38	48
84	224	42

31	79	51
218	174	34
249	31	239
194	171	201
105	80	270
136	690	103
173	60	279
66	44	55
272	79	56
51	485	446
95	275	70
47	70	201
50	35	172
41	184	183
68	214	62
171	291	49
843	169	259
65	213	135
53	63	146
459	61	98
264	61	225
113	613	71
171	37	261
46	154	115
57	489	358
317	55	229
37	31	147
316	26	59
70	77	27
109	307	41
86	52	49
54	165	410
62	210	2273
43	64	102
100	220	137
87	701	38
73	408	184
101	69	192
129	233	61
25	78	88
93	116	151
206	208	141
118	78	112
59	317	92
317	267	59
99	700	44
64	162	119

63	26	46
33	201	77
339	244	72
57	55	116
151	28	274
66	964	46
134	139	306
84	134	72
84	458	364
95	58	73
168	454	96
59	363	41
224	67	106
63	44	111
46	205	68
58	40	72
55	51	126
42	110	105
26	79	181
27	142	36
126	46	26
108	239	39
403	66	149
152	449	240
32	180	80
33	159	35
151	150	364
24	98	325
101	49	294
37	159	56
159	54	72
378	48	64
50	28	292
35	50	36
60	56	186
207	235	51
220	368	157
45	386	78
32	175	53
106	37	48
148	40	42
54	119	51
41	307	34
80	209	239
36	139	201
41	115	270
51	166	103

164	32	279
41	140	55
47	258	56
37	92	446
68	112	70
53	75	201
227	266	172
43	70	183
93	55	62
119	37	49
353	113	259
100	38	135
119	457	146
220	25	98
163	115	225
40	35	71
38	48	261
55	141	115
60	41	358
76	409	229
210	834	147
72	346	59
136	51	27
46	53	41
306	61	49
72	39	410
364	54	227
73	223	102
96	220	137
41	89	38
106	79	184
111	810	192
68	466	61
72	32	88
126	139	151
105	276	141
181	75	112
36	187	92
26	61	59
39	168	44
149	64	119
240	418	46
80	143	77
35	60	72
97	27	116
124	94	274
50	120	224

46
95
44
54
41
29

78
49
32
293
37
56

46
291
392

Diabetic subject #4 at 217 mg/dL glucose level

10	65	165
36	184	38
271	71	179
60	125	374
73	245	595
240	255	475
47	204	28
187	154	104
430	378	58
578	34	60
215	110	26
95	672	509
36	258	61
125	41	24
289	144	55
104	88	55
379	160	37
147	462	158
500	48	124
452	31	67
407	106	256
77	525	180
222	127	283
358	150	167
226	146	155
137	203	614
126	48	38
231	52	47
288	55	72
36	312	41
238	41	67
527	157	105
346	37	111
29	107	103
72	128	97
245	383	198
84	956	46
232	36	40
269	108	53
25	111	50
356	40	211
259	161	266
230	491	427
77	713	91

460	330	190
286	226	68
185	149	39
67	159	116
344	422	48
230	47	65
48	181	29
171	546	151
44	48	52
101	37	680
260	569	672
609	29	250
36	177	115
29	696	67
128	125	38
63	220	121
40	371	41
37	486	34
238	513	56
80	438	248
52	215	63
30	54	70
92	361	186
350	133	141
55	236	62
276	277	180
85	23	215
256	668	96
111	53	844
36	107	38
68	517	39
99	217	90
102	121	42
373	405	182
40	36	30
61	43	146
91	334	48
349	372	41
70	219	122
138	270	274
34	39	78
615	52	43
60	43	64
158	51	285
127	55	310
26	413	312
31	40	48

388	142	69
322	220	31
65	234	55
447	122	286
91	130	58
38	765	62
297	189	51
206	95	216
605	64	41
58	493	61
118	87	415
45	202	27
29	34	36
28	125	107
44	49	44
51	45	212
190	37	39
43	175	61
52	136	242
127	74	74
47	75	310
72	31	31
295	34	108
43	27	33
273	41	74
113	62	53
46	74	57
162	92	31
38	33	46
162	233	68
40	112	63
398	51	41
100	234	167
81	216	61
72	164	62
64	149	430
71	53	325
57	252	228
54	353	57
36	50	28
347	305	42
164	118	52
150	98	43
195	33	102
189	36	35
215	129	219
65	890	54

31	159	462
384	155	23
278	70	56
190	258	133
30	940	116
78	196	140
33	191	385
61	46	322
180	79	53
106	25	60
184	108	49
314	79	236
202	682	450
536	203	327
366	109	253
466	139	151
463	315	33
470	87	55
227	120	147
251	354	61
479	62	96
51	32	148
561	767	212
287	39	459
101	67	49
492	47	31
381	311	331
43	39	641
43	54	743
35	38	140
60	229	195
75	86	121
205	122	43
494	27	374
384	36	154
241	381	108
164	334	39
87	220	50
28	32	63
71	66	42
33	73	104
162	160	211
134	129	256
101	32	853
48	94	398
46	261	128
109	47	247

112	180	60
55	158	80
50	36	244
35	241	26
40	55	75
228	41	51
78	56	86
169	37	75
252	171	100
138	401	554
40	217	270
30	69	58
103	45	141
224	69	66
78	43	410
402	387	69
54	79	317
89	30	167
169	231	279
59	236	188
69	31	175
38	39	25
121	118	240
86	201	33
197	75	42
200	52	983
93	65	425
95	43	98
84	50	151
56	60	49
65	201	173
43	281	50
48	286	162
106	473	267
78	113	277
114	41	401
50	26	201
324	162	354
56	674	207
44	589	68
34	602	305
45	149	321
149	296	219
422	77	79
250	183	177
126	134	230
35	39	67

132	155	45
591	105	122
206	96	41
309	375	191
74	182	37
48	83	85
145	49	350
49	299	82
95	163	93
279	474	81
203	484	133
37	414	396
29	75	88
226	369	39
80	124	357
444	504	281
133	501	36
227	495	252
45	476	80
85	484	58
48	121	74
86	367	67
91	206	37
101	266	34
50	494	112
154	226	380
29	107	66
100	55	107
272	102	38
68	76	109
52	172	71
45	168	348
268	73	69
282	137	180
171	229	294
51	118	36
48	406	67
56	74	157
56	463	208
133	468	30
128	524	45
52	370	90
31	40	348
126	234	30
172	301	47
39	502	38
241	26	201

259	30	47
285	486	132
336	134	95
59	57	515
59	138	277
33	214	42
283	34	171
145	158	36
43	38	242
328	196	68
38	198	83
87	33	72
58	120	196
98	35	165
177	70	96
123	254	46
113	93	222
284	129	213
462	39	68
200	55	61
112	167	62
40	188	85
38	226	54
129	147	151
176	285	124
151	33	153
113	286	281
355	44	43
53	63	57
65	223	25
74	49	88
255	78	65
255	119	140
157	182	75
117	91	37
55	52	163
117	130	41
96	46	171
80	38	31
39	62	110
375	35	75
369	57	33
24	144	45
658	114	120
365	125	34
261	251	175
63	195	149

244	45	156
341	66	253
30	82	109
31	26	38
200	159	219
110	62	76
31	66	347
38	361	106
245	120	519
53	25	284
42	268	191
295	63	91
681	134	229
218	205	84
497	90	59
475	165	127
30	55	125
81	42	176
455	104	54
287	66	87
160	61	183
72	76	61
40	701	289
98	806	192
64	699	70
97	557	327
52	171	59
31	63	79
45	125	97
61	114	216
32	329	199
131	188	142
41	139	160
67	123	35
345	24	103
121	70	44
50	251	45
227	90	68
548	36	43
110	69	224
46	52	136
58	49	37
34	239	299
120	104	111
122	98	560
61	120	466
170	288	366

47	89	98
90	70	482
539	209	403
277	143	48
143	31	
169	37	
270	329	
34	68	
53	43	
374	34	
337	27	
158	32	
232	332	
41	78	
37	195	
249	170	
208	28	
339	220	
49	333	
31	230	
756	45	
36	37	
25	47	
623	43	
374	265	
491	513	
286	804	
293	40	
593	72	
644	58	
329	49	
40	92	
34	326	
48	51	
737	56	
195	51	
424	124	
43	133	
46	355	
28	160	
319	207	
25	48	
198	39	
259	43	
60	91	
58	155	
258	193	

239	202
48	246
314	436
90	336
103	527
820	71
722	716
558	954
295	399
369	39
478	131
824	183
680	46
28	441
229	59
112	190
271	142
31	70
47	71
57	48
257	35
158	49
50	137
233	59
398	138
167	147
394	48
51	57
64	43
42	39
242	68
378	145
303	83
72	316
356	170
196	27
80	58
379	31
635	215
881	31
167	55
117	635
79	969
41	26
65	395
359	246
144	317

238	147
36	29
379	329
46	457
34	54
27	51
99	119
683	72
76	32
50	59
258	212
261	29
110	42
33	77
192	57
259	415
436	48
445	98
33	40
127	62
28	207
341	74
169	102
278	45
280	279
257	51
122	212
137	27
704	95
42	49
45	97
455	50
31	58
59	33
451	123
220	80
109	58
55	56
26	25
52	117
88	69
111	205
253	114
198	38
128	428
42	105
403	503

102	98
113	52
69	60
32	26
263	92
86	208
25	124
375	36
136	235
38	252
40	182
129	34
326	89
898	68
242	192
730	40
161	93
153	48
44	34
212	324
48	98
203	150
321	53
111	89
382	65
67	98
452	105
316	439
437	122
148	34
473	103
461	221
40	557
358	280
388	138
75	74
252	227
201	24
700	661
69	104
158	144
120	40
56	60
74	171
192	44
41	38
172	101

65	66
98	33
248	37
302	29
244	81
63	53
403	76
315	57
173	203
42	69
25	64
33	38
40	70
45	372
43	92
58	200
98	292
33	105
71	275
37	285
33	202
80	379
114	459
39	260
372	272
167	53
190	117
979	343
39	123
526	460
146	479
234	2416
37	42
198	244
53	65
36	37
55	35
30	44
215	592

Diabetic subject #5 at 146 mg/dL glucose level

501	309	299
48	113	126
159	424	286
535	62	71
46	354	62
85	423	149
49	439	283
37	438	208
173	359	34
37	71	64
66	355	31
52	84	73
71	438	99
154	446	678
64	432	152
234	438	165
578	441	154
26	440	348
71	423	74
400	110	355
193	156	178
281	421	42
100	229	33
321	183	153
204	198	26
191	210	280
57	417	195
25	423	25
110	352	272
75	78	34
148	425	44
67	737	38
25	50	193
166	89	207
34	435	94
123	772	210
34	78	91
72	407	168
162	406	48
478	800	123
211	43	328
64	404	42
169	251	71
181	163	281

29	955	125
323	305	267
99	416	133
42	290	478
157	95	270
32	33	90
26	441	75
186	870	212
54	340	30
302	414	35
736	79	63
27	143	119
47	367	201
168	293	111
56	74	418
31	434	285
243	275	472
377	343	68
61	47	340
94	394	72
108	833	207
96	370	193
54	73	95
366	312	191
39	157	29
220	471	120
36	382	63
32	74	247
64	367	129
51	73	250
28	204	201
219	233	207
29	447	167
43	442	73
315	60	324
28	314	499
81	78	39
75	77	350
47	135	36
37	659	67
49	189	55
306	74	84
39	166	278
88	381	65
204	29	61
43	158	78
29	203	65

153	51	147
33	37	140
40	62	50
153	56	388
43	265	306
193	47	95
466	45	54
121	134	58
406	249	45
691	132	33
216	81	47
190	34	41
163	262	72
95	161	326
482	51	60
337	49	68
88	40	122
433	33	62
332	186	37
345	36	71
208	423	77
184	406	52
235	301	219
23	128	212
426	242	56
147	82	470
167	72	52
201	38	33
48	40	143
165	68	46
101	207	55
129	267	110
277	297	311
195	539	55
128	33	259
26	532	678
256	148	187
62	330	43
379	41	70
42	29	51
165	48	206
275	109	32
57	87	93
31	137	142
66	37	139
153	326	55
181	76	428

108	801	38
67	400	163
29	93	162
47	266	66
55	34	114
100	389	50
145	397	55
142	405	157
105	262	30
37	151	138
44	244	95
197	171	38
189	426	230
153	426	66
40	435	137
153	423	35
382	408	143
636	414	109
58	421	279
41	369	32
46	62	384
426	151	114
207	181	211
89	107	129
113	98	132
216	581	219
313	268	273
192	316	122
59	207	27
71	477	60
93	144	1397
32	260	32
210	62	559
187	204	1544
422	76	840
231	53	182
149	174	1620
44	37	757
61	365	25
53	231	1412
389	207	52
86	450	320
37	118	224
47	1795	29
57	170	61
51	76	307
62	150	574

153	250	136
63	395	3734
149	412	967
451	131	59
99	280	32
76	421	161
269	415	173
99	142	297
220	522	679
141	145	68
309	792	4773
460	31	313
121	333	33
189	218	59
52	123	864
492	108	135
128	167	292
711	104	470
55	167	215
131	65	772
260	190	91
42	249	121
155	172	104
34	83	520
36	63	147
56	176	221
98	48	25
47	84	449
128	324	32
322	204	24
64	56	167
85	55	790
116	86	130
40	48	168
202	54	767
31	32	839
60	49	234
35	221	603
771	124	850
99	163	149
111	35	266
76	276	878
56	37	347
224	100	34
97	153	105
33	760	49
714	190	537

138	60	949
62	202	137
54	55	112
59	26	114
38	488	320
246	78	28
94	241	959
25	45	113
145	750	115
34	157	120
135	99	143
108	55	229
30	132	107
52	262	367
603	363	318
143	251	671
87	30	25
142	64	172
286	41	632
138	129	136
81	210	36
197	71	77
295	150	92
122	257	25
87	269	584
172	969	44
301	144	152
74	32	196
38	248	215
36	70	61
48	342	243
160	52	258
27	453	41
618	280	39
203	134	549
55	237	235
91	27	687
33	60	126
50	30	281
226	148	129
43	194	267
50	137	150
190	54	425
49	560	31
28	334	616
68	75	859
289	63	85

78	140	42
446	27	53
156	87	80
720	147	196
417	59	160
277	77	50
406	200	159
33	51	151
125	115	345
582	73	185
51	63	52
405	77	424
42	57	176
288	54	197
591	346	799
135	43	106
271	395	29
511	53	194
370	841	59
71	28	54
90	32	46
772	28	40
95	586	298
445	46	198
446	239	244
444	68	219
192	32	798
62	613	464
37	57	516
134	57	53
78	123	263
56	87	1795
133	43	1707
31	66	862
67	396	1553
138	48	236
38	970	2123
106	43	58
85	509	122
31	336	127
30	56	78
44	54	260
37	166	523
295	230	47
335	167	49
149	390	395
35	48	35

172	363	146
176	322	54
619	481	434
113	149	916
171	280	28
42	40	29
115	96	46
36	399	59
163	211	31
257	97	58
35	890	285
251	39	790
209	62	144
194	96	29
224	242	117
434	29	356
445	151	185
438	537	200
447	60	143
211	185	97
238	28	292
432	387	48
351	503	216
75	137	302
389	27	47
33	114	55
103	54	188
86	107	34
215	282	42
94	66	210
316	41	49
767	75	215
510	101	392
420	178	384
315	124	63
108	735	407
429	40	301
410	55	399
302	96	425
122	727	437
260	62	37
75	58	784
129	193	47
296	133	117
36	170	107
34	45	52
56	219	50

53	281	153
245	94	132
98	207	101
229	77	134
70	67	309
73	250	34
49	276	290
33	42	101
46	116	196
135	65	67
74	41	182
130	70	37
115	204	627
78	30	52
96	206	29
244	88	383
75	95	34
104	222	90
173	289	196
137	44	63
266	37	91
278	41	107
61	59	103
224	382	196
145	61	145
327	214	82
89	106	369
421	919	38
417	341	150
441	41	92
127	28	115
67	647	325
448	201	146
450	440	109
447	435	278
349	189	309
95	240	85
157	272	151
529	40	242
100	448	141
292	257	117
67	85	145
112	152	398
91	100	403
150	707	398
159	89	387
65	106	153

51	83	256
202	128	313
72	242	72
40	526	395
45	404	398
41	36	408
568	69	248
98	32	26
481	523	140
151	224	256
303	274	63
67	82	91
79	39	414
120	69	110
726	128	302
34	81	232
779	78	203
630	313	474
40	399	247
73	399	402
51	422	348
414	879	145
364	137	392
362	292	381
31	440	258
227	429	128
217	558	306
108	257	143
463	400	233
315	664	60
153	60	565
284	295	203
31	199	219
275	75	174
147	129	43
754	163	221
502	45	84
42	111	267
39	169	58
262	40	37
260	183	125
252	60	165
598	237	25
221	112	29
349	290	68
132	63	29
32	135	137

373	517	40
749	900	33
115	56	40
194	37	55
125	307	92
31	211	136
492	40	63
37	156	150
37	412	38
57	174	31
39	322	60
57	227	52
38	127	40
39	280	177
54	165	42
103	251	39
224	332	40
64	185	40
27	54	168
68	191	61
186	682	40
298	60	68
76	567	40
38	359	29
216	130	100
31	400	77
138	595	80
94	30	43
258	128	40
49	63	281
61	199	78
227	306	271
284	32	211
186	137	42
71	42	452
68	750	77
171	107	66
30	147	93
313	259	361
385	129	47
626	570	60
526	42	35
852	601	57
96	125	37
294	935	65
84	428	81
34	37	63

217	66	50
73	33	43
734	59	73
268	28	26
35	82	81
112	29	55
54	189	81
207	183	83
110	29	142
37	38	238
165	707	348
512	362	65
290	423	38
31	113	502
99	71	127
263	75	54
54	245	302
49	39	87
36	309	51
65	31	295
30	36	30
192	453	48
246	665	223
619	227	98
565	121	43
973	97	341
192	309	460
220	350	83
591	75	161
543	407	205
274	376	134
162	75	42
247	390	161
53	51	59
67	454	61
58	463	38
142	388	51
445	31	65
95	40	77
135	354	113
273	105	76
291	297	98
341	152	43
164	102	118
392	109	95
286	233	29
113	153	44

333	82	66
67	77	83
210	45	121
530	67	70
74	426	168
426	306	111
425	525	102
101	420	30
676	421	156
75	114	195
209	135	32
207	170	153
418	150	443
402	698	57
407	816	113
823	49	212
433	404	33
753	40	62
504	450	34
399	70	66
390	241	79
316	147	76
51	461	87
25	381	51
327	80	27
75	132	52
409	324	378
410	87	141
413	744	221
414	160	478
426	102	81
428	124	93
415	108	61
613	413	228
224	344	267
70	91	107
345	52	80
346	287	71
76	79	80

Diabetic subject #5 at 226 mg/dL glucose level

301	33	40
434	326	34
447	77	137
78	147	93
364	91	104
388	425	265
158	228	62
173	192	47
215	62	675
97	183	625
410	168	601
96	74	324
244	74	334
651	270	88
122	229	304
76	96	67
237	83	44
28	76	161
249	317	53
32	319	67
179	75	161
59	392	36
80	594	47
65	404	851
325	402	113
39	290	42
512	114	550
33	398	195
144	403	26
48	407	280
768	340	121
464	78	605
146	393	43
30	26	29
37	189	57
244	657	36
44	85	31
994	337	183
187	415	326
144	338	42
49	75	543
26	402	152
530	391	85
225	388	43

299	388	152
233	401	33
330	409	73
365	421	65
758	341	89
49	92	52
609	324	45
67	99	463
511	431	88
377	420	142
221	413	353
171	369	197
362	273	46
50	41	68
32	52	133
37	99	53
66	172	179
35	70	444
162	25	442
53	102	438
67	56	258
87	499	42
122	34	90
729	120	42
42	52	72
126	195	306
280	105	42
853	188	290
148	114	433
313	32	139
56	255	392
259	92	305
568	191	70
139	113	59
59	77	230
130	369	417
58	425	43
399	56	33
250	198	55
62	121	67
337	29	59
39	36	30
307	265	193
345	52	506
45	389	146
116	54	44
28	78	554

41	61	39
173	167	55
94	48	27
76	120	56
26	26	222
241	70	770
42	187	143
124	31	30
170	69	34
56	143	426
144	209	454
48	84	79
63	56	39
37	155	331
196	43	216
237	51	278
189	85	54
201	69	387
50	70	58
110	103	297
48	154	941
191	71	297
83	149	136
215	35	67
138	56	24
274	139	51
46	26	90
36	197	32
124	209	34
35	58	50
554	284	41
171	30	65
48	55	71
238	66	131
74	66	243
29	238	193
203	216	114
34	41	67
204	73	31
34	208	181
56	36	68
46	201	62
83	217	347
339	80	64
86	200	65
133	95	156
37	110	87

238	107	39
52	40	117
199	161	81
81	122	73
228	55	26
284	74	148
55	384	116
174	39	160
199	63	35
37	56	193
531	168	82
198	154	47
196	146	46
118	198	135
164	48	215
125	49	102
28	79	32
284	152	50
132	25	31
113	196	96
295	43	228
212	26	57
86	368	57
385	201	69
196	60	96
160	94	497
149	83	32
411	81	72
408	169	138
101	150	149
398	110	102
51	75	69
61	27	117
629	51	173
428	73	100
361	127	117
51	56	294
128	40	191
49	37	223
596	47	58
41	72	45
120	94	39
38	140	35
117	315	80
68	73	27
47	82	79
272	418	93

431	190	105
338	307	123
315	431	68
278	40	357
222	53	41
205	184	31
513	73	70
33	82	144
373	45	110
25	169	44
37	508	280
289	40	192
745	125	61
50	43	118
33	48	655
118	60	96
562	69	378
65	28	71
76	50	450
48	48	456
32	384	187
42	153	186
188	70	216
54	55	385
383	257	319
24	86	480
347	77	359
131	75	75
41	109	371
42	35	49
164	107	340
27	166	356
289	530	156
31	221	277
81	55	256
86	125	271
64	30	606
45	37	208
65	283	343
77	245	79
337	47	439
162	55	332
858	77	122
294	347	190
108	83	125
635	62	134
196	29	153

78	55	130
29	284	376
79	78	216
398	61	60
112	249	306
300	41	55
778	69	108
114	95	110
154	54	84
113	288	36
153	72	69
55	248	405
268	28	407
356	145	413
46	78	419
95	98	428
193	234	441
28	44	136
297	86	131
77	35	70
32	50	934
94	109	531
45	137	624
280	91	112
74	187	132
304	92	418
113	50	323
126	31	111
53	451	554
29	83	522
39	30	228
120	144	516
57	172	343
65	51	147
248	198	207
692	42	411
39	40	81
297	177	279
159	136	95
51	29	46
239	27	271
50	48	143
47	255	445
189	117	437
45	79	37
53	281	324
55	286	325

150	97	178
78	47	199
57	151	236
42	59	440
34	65	441
41	126	667
320	84	212
42	55	429
76	166	430
51	199	307
27	266	131
263	53	655
312	80	201
74	62	417
306	189	415
87	332	441
388	49	441
384	190	444
34	38	149
407	183	242
405	463	37
326	119	427
117	68	337
34	35	93
82	240	440
50	255	439
42	275	238
190	333	104
117	78	509
149	409	86
63	404	360
158	408	435
154	549	370
80	426	77
146	432	343
35	433	517
58	398	248
56	37	198
67	203	443
28	233	674
214	74	328
95	283	285
51	75	432
178	446	429
122	268	773
58	289	80
98	192	215

39	44	1570
88	157	362
101	107	442
350	34	105
48	72	331
161	512	354
36	427	81
71	426	523
41	450	186
88	438	139
58	434	417
150	233	458
72	194	119
99	430	93
55	431	167
171	357	165
106	76	74
31	434	627
50	156	46
35	715	236
129	311	272
100	375	174
64	44	27
38	188	85
280	149	156
96	940	92
73	792	640
275	200	246
207	95	92
87	263	301
29	37	252
43	907	29
190	45	61
163	232	191
46	179	62
91	309	40
432	54	143
170	40	161
30	287	192
53	288	81
25	35	39
63	213	296
68	347	488
590	386	343
157	42	423
40	26	114
69	241	288

37	99	404
135	50	37
151	47	516
111	352	257
52	56	331
74	163	74
48	186	406
35	148	739
72	102	71
111	45	410
51	126	399
64	134	396
28	29	390
327	64	201
54	194	58
51	248	144
31	60	242
264	12	88
142	90	76
35	59	402
46	59	77
61	33	552
43	178	156
40	35	41
38	399	415
314	218	234
63	74	170
62	305	396
154	449	216
50	41	73
98	66	109
33	234	166
62	300	90
88	310	129
42	36	307
44	286	69
122	438	44
32	508	227
45	408	177
68	80	63
247	190	103
150	77	122
149	112	182
56	34	36
305	402	306
448	43	502
57	166	280

369	346	140
263	138	32
83	210	30
76	24	186
334	251	133
78	195	51
146	56	285
264	129	63
408	36	76
320	306	122
100	62	79
351	45	380
302	44	423
173	108	92
35	298	145
64	121	39
176	56	49
322	207	76
572	249	176
138	127	424
170	50	201
168	27	174
118	47	91
412	146	75
332	59	348
70	521	88
218	31	45
36	25	334
422	23	474
62	262	123
131	170	342
123	47	74
120	75	413
42	62	417
203	368	562
226	32	412
47	389	90
218	151	141
126	227	229
156	210	43
425	675	435
110	29	342
151	53	77
46	53	36
56	69	82
263	329	61
382	628	152

152	278	173
236	131	60
99	320	156
153	211	41
35	961	171
75	222	131
44	41	33
130	68	81
100	916	636
192	52	42
66	180	104
307	63	200
180	516	106
31	270	93
84	269	30
426	304	47
64	48	106
358	908	185
237	323	62
218	405	30
36	204	71
124	142	36
264	402	488
156	288	59
84	164	162
83	40	156
55	63	189
116	60	133
143	643	93
32	172	34
95	43	65
238	576	137
182	143	260
340	30	424
222	140	55
26	557	27
338	597	74
37	184	723
79	779	134
378	172	111
366	537	80
360	42	208
419	101	151
455	776	251
332	109	245
61	56	100
48	235	50

35	64	208
269	63	63
62	386	33
377	249	30
260	112	46
51	40	147
420	47	511
58	42	104
161	188	71
189	50	116
47	118	25
56	151	48
330	28	156
294	31	321
206	65	28
848	32	83
333	396	301
95	105	81
432	202	188
429	196	202
278	61	376
144	74	335
419	53	202
143	53	277
266	69	407
413	26	554
410	45	159
408	92	640
66	134	240
344	235	30
137	315	229
277	148	215
415	34	436
152	59	44
326	40	220
407	408	328
292	69	219
122	153	65
420	238	41
434	62	42
436	27	364
438	90	428
434	59	164
573	80	169
429	122	80
424	137	181
261	26	27

153	190	258
412	404	362
414	82	55
416	762	260
297	64	51
118	64	208
420	39	225
272	30	135
147	111	252
259	348	639
170	151	606
395	40	185
24	32	139
70	273	40
80	175	23
267	55	175
414	54	566
412	222	58
416	38	238
450	72	533
299	136	477
76	144	25
443	45	187
177	139	278
58	38	67
615	27	
420	49	
424	65	
425	47	
421	201	
430	83	
418	178	
419	52	
412	26	
411	51	
338	39	
75	88	
214	53	
370	60	



THE UNIVERSITY OF TEXAS AT EL PASO
Office of the Vice President for Research and Sponsored Projects
Institutional Review Board

El Paso, Texas 79968-0587
phone: 915 747-8841 fax: 915 747-5931

FWA No: 00001224

DATE: July 25, 2011

TO: Reza Amanipour, B.S

FROM: University of Texas at El Paso IRB

STUDY TITLE: [243597-1] Investigation into the Effects of Blood Glucose Levels on Specific Features of HRV Signal in Persons with Diabetes

IRB REFERENCE #: 243597-1

SUBMISSION TYPE: New Project

ACTION: APPROVED

APPROVAL DATE: July 25, 2011

EXPIRATION DATE: July 25, 2012

REVIEW TYPE: Expedited Review

Thank you for your submission of New Project materials for this research study. University of Texas at El Paso IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a study design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This study has received Expedited Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the study and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document.

Please note that any revision to previously approved materials must be approved by this office prior to initiation. Please use the appropriate revision forms for this procedure.

All SERIOUS and UNEXPECTED adverse events must be reported to this office. Please use the appropriate adverse event forms for this procedure. All FDA and sponsor reporting requirements should also be followed.

Please report all NON-COMPLIANCE issues or COMPLAINTS regarding this study to this office.

Please note that all research records must be retained for a minimum of three years after termination of the project.

Based on the risks, this project requires Continuing Review by this office on an annual basis. Please use the appropriate renewal forms for this procedure.

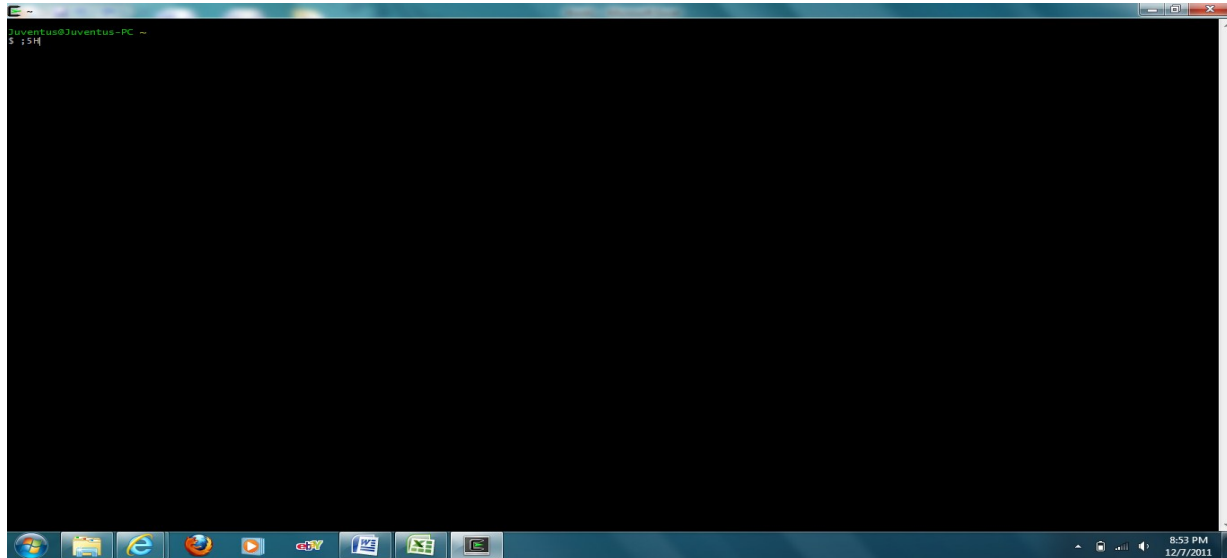
If you have any questions, please contact Athena Fester at (915) 747-8841 or afester@utep.edu. Please include your study title and reference number in all correspondence with this office.

Appendix F

Example of Physionet software steps:

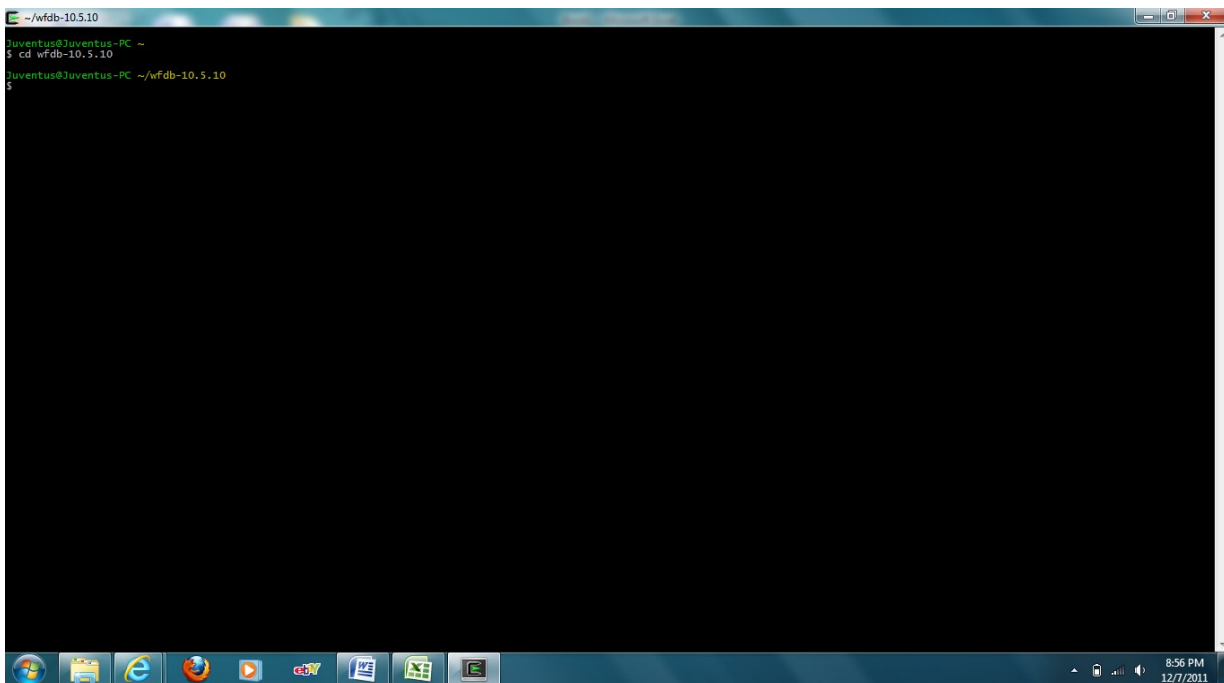
Text file called Example containing ECG raw data was created from the excel file (output of BioRadio 150 device).

Open a Cygwin window by double clicking on the Cygwin icon:



Enter the correct directory address by using command below:

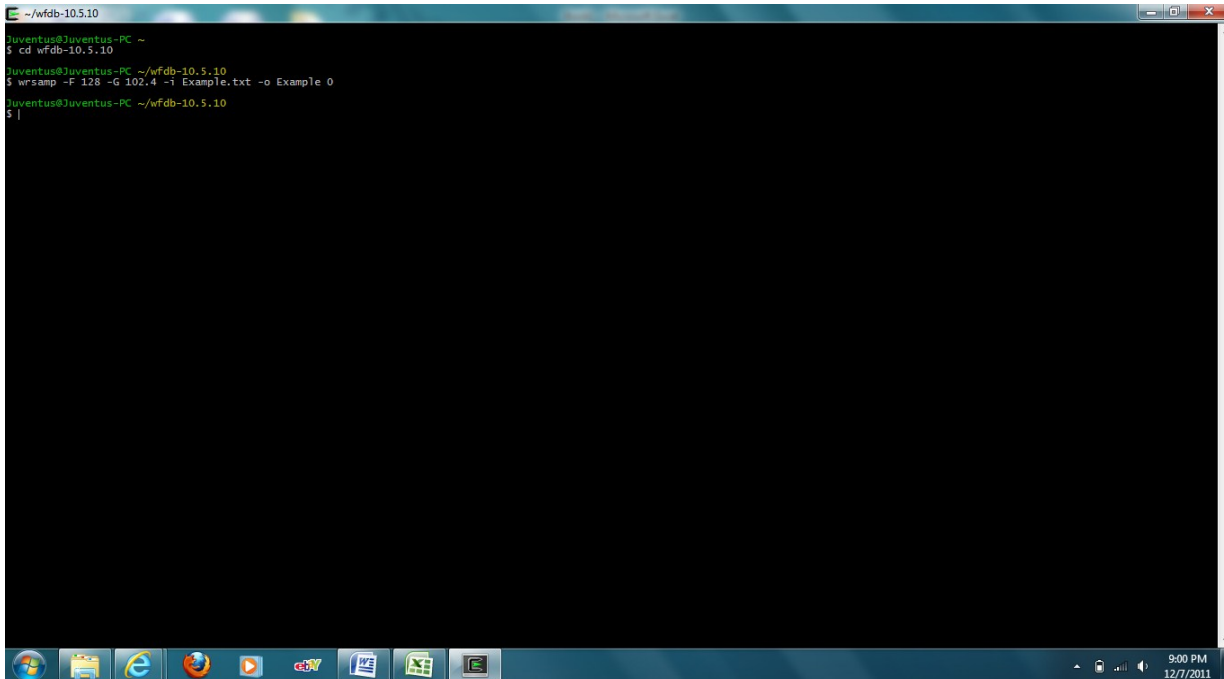
`cd wfdb-10.5.10`



Placing the "Example.txt" file in the wfdb-10.5.10 directory

Creating the PhysioBank compatible record by using the command below:

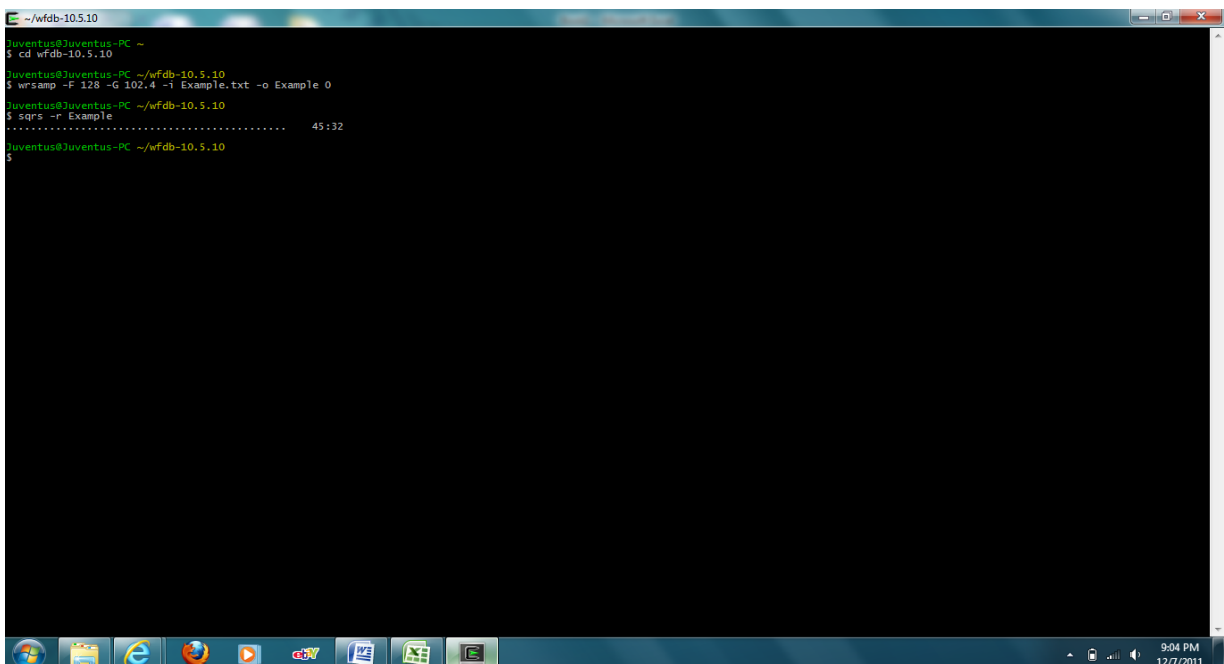
wrsamp -F 128 -G 102.4 -i Example.txt -o Example 0



```
~/wfdb-10.5.10
Juventus@Juventus-PC ~
$ cd wfdb-10.5.10
Juventus@Juventus-PC ~/wfdb-10.5.10
$ wrsamp -F 128 -G 102.4 -i Example.txt -o Example 0
Juventus@Juventus-PC ~/wfdb-10.5.10
$ |
```

Detecting QRS complexes by using command below (creating the annotation file):

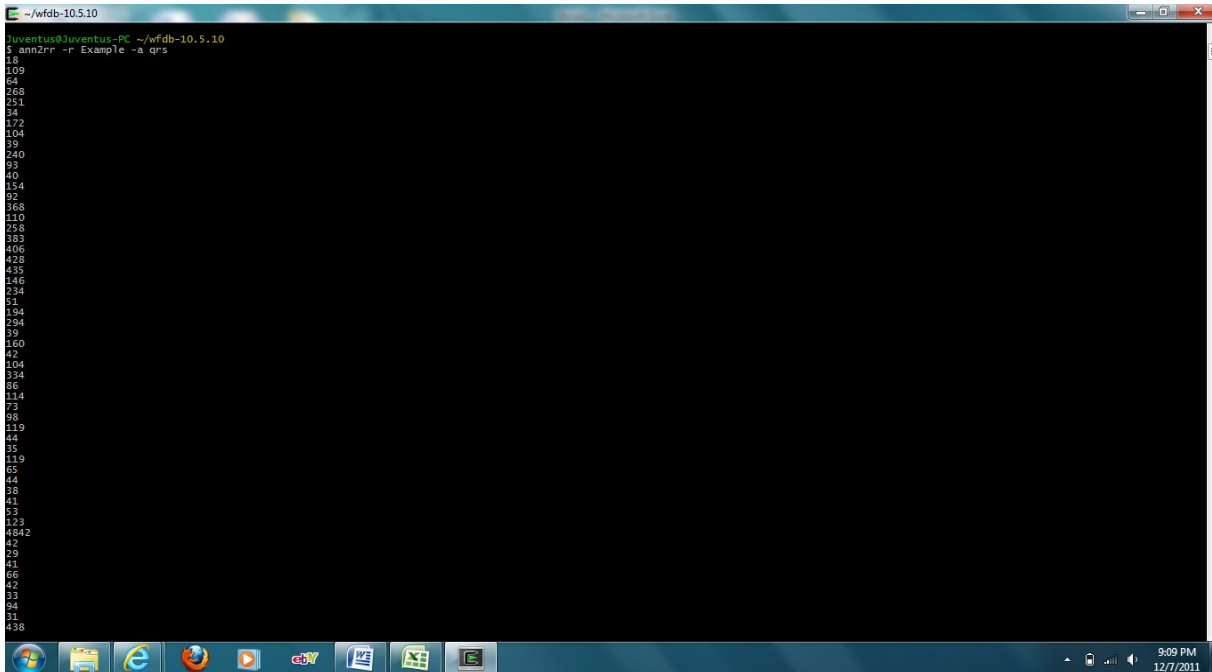
sqrs -r Example



```
~/wfdb-10.5.10
Juventus@Juventus-PC ~
$ cd wfdb-10.5.10
Juventus@Juventus-PC ~/wfdb-10.5.10
$ wrsamp -F 128 -G 102.4 -i Example.txt -o Example 0
Juventus@Juventus-PC ~/wfdb-10.5.10
$ sqrs -r Example
..... 45:32
Juventus@Juventus-PC ~/wfdb-10.5.10
$
```

Extraction of RR intervals from the annotation file by using command below:

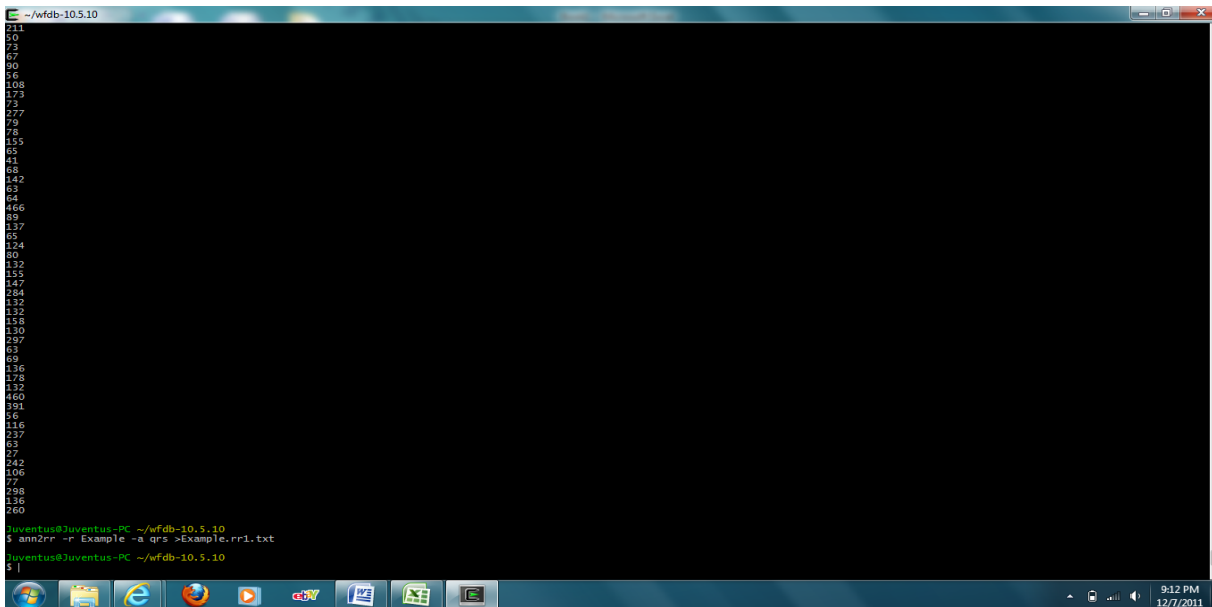
`ann2rr -r Example -a qrs`



A terminal window titled `~/wfdb-10.5.10` showing the command `ann2rr -r Example -a qrs` being executed. The output is a list of 50 numerical values representing RR intervals, displayed one per line. The values are: 18, 109, 64, 268, 251, 34, 172, 104, 39, 240, 93, 40, 154, 92, 168, 110, 258, 383, 406, 428, 435, 146, 234, 51, 194, 204, 39, 160, 42, 104, 134, 86, 114, 73, 98, 119, 44, 35, 119, 65, 44, 38, 41, 53, 123, 4042, 42, 29, 41, 66, 42, 13, 94, 31, 438.

Writing the extrated RR intervals into a text file by using command below:

`ann2rr -r Example -a qrs >Example.rr1.txt`



A terminal window titled `~/wfdb-10.5.10` showing the command `ann2rr -r Example -a qrs >Example.rr1.txt` being executed. The output is a list of 50 numerical values representing RR intervals, displayed one per line. The values are: 211, 10, 73, 67, 90, 56, 108, 173, 73, 277, 79, 73, 155, 65, 41, 68, 142, 63, 64, 466, 89, 137, 63, 124, 80, 132, 133, 147, 204, 132, 132, 158, 130, 297, 63, 69, 136, 178, 132, 460, 301, 36, 116, 117, 63, 27, 242, 106, 7, 298, 136, 260. Below the list, the prompt `juventus@juventus-PC ~/wfdb-10.5.10` is shown, followed by the command `ann2rr -r Example -a qrs >Example.rr1.txt` and the prompt `juventus@juventus-PC ~/wfdb-10.5.10` again.

Curriculum Vitae

Reza Amanipour graduated from high school in 2001 from Kavosh high school in Iran. Reza enrolled in the electrical and computer engineering program at Baylor University in Fall 2005. During his junior year at college he had an internship at the UT Southwestern medical center at Dallas. During that time Reza gained an interest in the biomedical research. He enrolled in the graduate school at The University of Texas at El Paso in the Spring 2010 and started working as research assistant at the Biomedical lab in the biomedical areas of electrical engineering. In Spring 2011 he went on to present a conference paper at the SBME conference in Arlington, Texas on the Specific features of HRV signal in persons with diabetes. Reza was a member of electrical engineering honor society (HKN) at The University of Texas at El Paso.

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This thesis was typed by Reza Amanipour.