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Date: 2025-03-02

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**The Factors that Affect Insulin**

**1 and 2**

Article 1 - National Library of Medicine - Role of Insulin Health and Disease: An Update

This article provides an update on the insulin health and the research surrounding it. How insulin levels affect our health and role in developing diseases. It states that the research it has done shows insulin deficiency make it difficult (uses the word impossible) for cells to use glucose as energy. When someone is not able to use glucose they become dependent on fat for energy and this leads to other diseases (blood related diseases). The liver, skeleton and heart were mentioned as parts of the body which were negatively affected when insulin levels were too low. The article finished with the conclusion that there is still a lot that is unknown regarding insulin, the diseases associated with insulin levels and the therapies which treat these diseases.

<https://pmc.ncbi.nlm.nih.gov/articles/PMC8232639/>

Article 2 - Cleveland Clinic – Insulin

The Cleveland Clinic article does a terrific job explaining the relationship between insulin and glucose. It reads that insulin is a naturally occurring hormone the pancreas makes which help give your body energy. The insulin that is created moves the glucose or sugar throughout your body. Low insulin levels lead to the sugar not moving through your body and creating high blood sugar levels (which leads to diabetes). Hormones your body creates naturally balance your body’s sugar levels. There is a risk of having too much manufactured insulin in your body when you have diabetes and there is no normal level of insulin as every person is different. Your healthy insulin level can even vary throughout the day. The food you eat, your activity level (even what kind of exercise your are doing), stress levels, whether you are sick or on any other medications can all effect what your current insulin level is at.

<https://my.clevelandclinic.org/health/body/22601-insulin>

Article 3 - BMC Medicine - Insulin: too much of a good thing is bad

The article reviews what occurs when insulin levels are too high. They impede the bodies ability to preform its functions. It outlines what Hyperinsulinemia is; which is when insulin levels are too high in a person. It can cause a person to have cardiovascular diseases as well as problems with obesity. It outlines that even insulin shots can lead to an increased appetite and weight gain as the opposite is true regarding shots to lower insulin production (can lead to weight loss). Another term it discusses is insulin toxicity; which is when our cells are exposed to constant high insulin levels. This leads to the body not being responsive to the tools available which can show a person has high insulin levels.

<https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-020-01688-6>

Article 4 - Nebraskamed.com – The difference between insulin resistance and prediabetes

This article explains two terms in the insulin world; insulin resistance and prediabetes. Explaining that insulin resistance is the most common cause of prediabetes. Prediabetes is where your blood sugar levels are high but has not reached the diabetes level. Showing that the pancreas is not creating enough insulin to maintain healthy levels. Insulin resistance is where the pancreas is asked to create even more insulin to maintain the healthy level. It states that prediabetes does not have any symptoms and the only way to spot is through testing. Age is the only factor which the article suggests has a bearing on whether someone should be getting regularly tested (over 35).

Insulin resistance has symptoms which includes darkening of the skin and untreated insulin resistance can cause many other issues such as liver disease, cholesterol problems, high blood pressure and heart disease. It also lists factors that can increase the risk of the two conditions; family history, obesity, diet, lack of exercise and ethic background.

https://www.nebraskamed.com/diabetes/the-difference-between-insulin-resistance-and-prediabetes

Article 5 - YaleMedicine - Hyperglycemia: Symptoms, Causes, and Treatments

The article covers Hyperglycemia which it lists as a condition where glucose levels in the blood are higher than normal. A person will urinate larger amounts than usual, have an increased appetite and a feeling of being tired. It reports that this can affect someone at any age and can also include where a person’s body doesn’t respond to the insulin being created correctly. Which causes the glucose to not be moved throughout the body. It is common among people with diabetes and can be triggered by many situations such as: eating too many carbohydrates, lack of exercise, other medical conditions and stress. This is a condition where insulin medications may be prescribed to assist in bringing the glucose levels to a healthy level.

<https://www.yalemedicine.org/conditions/hyperglycemia-symptoms-causes-treatments>

Article 6 - Verywellhealth - Hyperinsulinema (High Insulin Levels)

This article covers the topic Hyperinsulinema. It describes hyperinsulinema as having high insulin levels in your blood which is caused by another term; insulin resistance. Insulin resistance is described as when your body doesn’t respond to the insulin your body is producing. The insulin is not moving the glucose throughout the body and your body is being asked to produce more insulin which gives a person high insulin and high blood sugar levels (glucose). The article argues that insulin resistance and hyperinsulinema cause each other; with different experts arguing for one causing the other. Race, gender and age can all be factors in Hyperinsulinema. In addition to this the article lists fatigue, lifestyle and obesity as being symptoms to the disease.

https://www.verywellhealth.com/hyperinsulinemia-is-associated-with-type-2-diabetes-1087717

**3.**

The National Library of Medicine (1) article relates to the projects goals in that it outlines how low insulin levels can result in different diseases such as diabetes. It also covers the fact that low insulin levels can result in high glucose levels. Multiple of the factors which the project is analyzing the link to insulin are mentioned as having a correlation.

The Cleveland Clinic (2) article relates to the project providing background information on insulin including describing its function in keeping the body healthy. The benchmark for what a healthy insulin level can change throughout the day and can vary from person to person. This means that our three levels of what is considered a high, medium and low insulin level can only be estimates.

The BMC Medicine (3) article relates to the project in that it discusses one of the factors we are trying to show the correlation of the other factors, a high insulin level. Higher insulin levels effect a person’s ability to be active by affecting a person’s basic functions. It also increases a person’s appetite which causes difficulties in a person maintaining their body mass index.

The Nebraskamed.com (4) article outlines insulin resistance and prediabetes and how they link to blood sugar levels and insulin. High blood sugar levels can be present without diabetes (which is called prediabetes); one of the factors can be present without the other. Insulin resistance will cause higher insulin levels even though the insulin is not performing its task of moving the glucose away efficiently. There are other factors in the data that show up as factors which can increase the risk of having the two conditions; age, physical activity and diet (which can affect glucose levels).

The YaleMedicine (5) article covers a condition called Hyperglycemia which shows higher than normal glucose levels. There are similar factors in the data which overlap in this condition such as physical activity, too many sugary foods and a desire to eat too much. One of the treatments is insulin shots to raise the insulin levels. This shows there are other conditions other than diabetes which can effect the same factors.

The Verywellhealth (6) article covers the topic Hyperinsulinema. Which outlines insulin resistance as the body not responding to the insulin that the body is producing. This causes high glucose levels and high insulin levels. With it being studied which causes which; do high insulin levels cause insulin resistance or the opposite. The article gives us the perspective that some of the factors could be the cause of high insulin levels or the opposite may be true where the high insulin levels are what caused problems with physical activity, BMI or glucose levels.

**4 5 6 7 8 9 10**

The data has been imported and cleaned. The original data had factors with role’s Target and Other based on the original work and analysis that was previously done. Which was comparing the factors to the age of the participates. The age factors were added to the data frame to create a data frame for this analysis. The subject for the study which the data was gathered for is around surveying the U.S. population and gathering information around their health to narrow down the factors which contribute to a person having diabetic or insulin issues and the correlation to their age. The subject for this analysis is to compare those same factors (age included) in their role in a person’s insulin levels. To determine if there are any strong correlations or multiple strong factors which can cause an insulin level to be low or high.

I have chosen the dataset from UC Irvine Machine Learning Repository called National Health and Nutrition Health Survey Age Prediction subset. It holds 7 features (including insulin levels, if the respondent is diabetic, senior status, age, gender and physical activity) and there are a total of 2278 respondents.

The code for the data checked for missing values, summary statistics were presented, mean/median/mode were presented, box plots of the numeric factors, a count of the how many participants were which gender, and a count of the age category participants find themselves in. Creating categories for different levels of insulin in a person’s system and a correlation matrix with a heat map.

The gender counts show that there is an even number of both genders in the study (1165 Female/1113 Male). The age count shows the data set has majority people aged under 65 and majority do not take part in the regular exercise. The diabetes question only had 21 participates having diabetes and 58 borderline diabetic. The box plots showed many outliers for the Body Mass Index, Glucose levels after fasting and Glucose levels in Oral testing. I will be running the decision tree and KNN with and without the outliers to see how they impacted the results.

Summary Statistics show the Body Mass Index, Glucose after fasting and Glucose levels in Oral testing that most of the participants fell closer to the lower side of the results. The median and mean for all three were over the 50% percentile which shows most of the results were on the lower side. The max and low standard deviation to the total range for both the glucose results would also suggest there are outliers in the results.

The correlation matrix and heat map showed only the glucose factors have stronger correlations amongst the factors; Glucose levels after fasting and Glucose levels in Oral testing. The Body Mass Index has the strongest correlation to the insulin levels with the exercise results having the next strongest correlation. The rest either came out with a negative correlation or a very low number close to 0.

The categories for the insulin were broken down into four categories: low (0-10), medium (11-15), high (16-30) and very high (30 and above). The research and readings showed that there is a clear definition of what a low or high insulin level is so I used ranges which provided sizable portion of the population in each. When I run the analysis without the outliers I expect the very high section to be almost empty.

Using the KNN and a decision tree I will determine if any of the factors prove to have a strong relationship to each of the insulin categories. In particular the low and high categories which the articles showed me are both problematic which can lead to diseases and poor health. We also attempt to see how influential a person’s weight (BMI) and physical activity can have a person’s current insulin levels. Multiple articles suggested that a poor insulin level (insulin not moving the glucose throughout the body) can leave a person feeling constantly hungry and/or fatigued.

Data path:

<https://github.com/Mac0227/pwork/blob/main/AM%20Final%20Project.ipynb>

Dataset location: <https://archive.ics.uci.edu/dataset/887/national+health+and+nutrition+health+survey+2013-2014+(nhanes)+age+prediction+subset>

Articles:

<https://pmc.ncbi.nlm.nih.gov/articles/PMC8232639/>

<https://my.clevelandclinic.org/health/body/22601-insulin>

<https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-020-01688-6>

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https://www.w3schools.com/python/python\_ml\_decision\_tree.asp