MTFC Scenario Quest Response 2024-25

Team Name	Less Than Three
Team ID #	19717

Part 1: Project Definition *(Diabetes Topic Prompts)*

#1: Who is at risk?
The primary demographic at risk of loss after diabetes diagnosis and treatment is the patient. The patient loses money paying for medications like insulin and they risk their health. Additionally, medical insurance companies that are funded by the government, like Medicare, are at risk of losing more money trying to fund insulin and other medications that are expensive, given they need to be taken every day. Similarly, the people/caretakers that are responsible for the financial burden of the patient(s) with diabetes would also be at risk because they have to assume the cost of medication, treatment, and potential complications that may arise with diabetes.

#2: Defining the risks
Insuracare Co. must consider the increased cost of care for policyholders who have diabetes because they typically require more life-saving treatment (meaning that the insurance company *must* pay for all the related costs according to their policy). Insuracare likely has to pay much more on average for a policy holder that has diabetes compared to a policyholder who doesn't. As such, the claim amounts for policyholders with and without diabetes is a crucial factor to consider. Insuracare Co. should also consider the number of policyholders who may switch to a different insurance company depending on their past history of insurance plan lengths.

#3: Identify Risk mitigation strategies
To mitigate losses for Insuracare through a behavior change, Insuracare could encourage its policyholders that are at risk of or have diabetes to adopt a healthier lifestyle that involves a nutritious diet and consistent exercise. Additionally, to mitigate losses by modifying outcomes, Insuracare could form partnerships with medication suppliers to provide cost effective treatment to diabetic patients. Insuracare could also get insured to help minimize their losses.

Part 2: Data Identification & Assessment *(Diabetes Topic Prompts)*

#4: Identifying the type of data

In the Actuarial Process Guide, three categories or types of data are identified that may be valuable in analyzing risks and making recommendations on mitigation strategies. The data provided on the diabetes prevalence and insurance claims for this scenario includes some valuable information and includes everything needed to be able to address the prompts in this Scenario Quest. For your own topic, you will need to identify your own data and evaluate whether the data you have identified will enable a good data analysis. Which of the three categories of data identified in the Actuarial Process Guide are provided in this scenario's dataset (Tab #1: Diabetic Insuracare Claims 2021 and Tab #2: US Diabetes Prevalence Trends 1999-2015)? Explain (at a high level) what information and insights these datasets can provide in 2-3 sentences.

The three main types of data are:
1. Data that helps categorize risk
2. Data that defines historical frequency
3. Data that defines risk severity

The dataset provides both age and gender to aid in categorizing risk. Additionally, the annual medical costs are a good way to measure the severity of the financial risk caused by diabetes. We are also provided the number of claims for each patient, helping us to potentially determine which groups are most likely to report a high number of claims. Historical frequency is also a factor that can be considered, shown in the dataset through the date of testing. The day of testing may be a factor worth considering depending on if we can see a growth rate over time and whether the growth of cost correlates over time.

#5: Insuracare Reserves

The total loss that is incurred from both medical and pharmaceutical costs is $6,490,347.76 USD during 2021. We calculated this by adding the total annual costs (medical + pharmacy) across all policyholders present within the database.

#6: Diabetic policyholder total claim average & standard deviation

The average claim amount per policyholder present in the database is $12,980.69 USD. For this average, the standard deviation is $12,641.58 USD.

The total claim average is the amount of money Insuracare has to pay for a year for a single diabetic policyholder. The standard deviation is the average variation of how much Insuracare pays per annual claim, whether it be over or under the mean.

#7: Average pharmacy claims costs

We calculated the average pharmacy claim costs for insulin to be $4,866.10 and the average pharmacy claim costs for Metformin to be $211.64. This resulted in a total pharmacy claim cost of $4,174.85. This suggests that Insuracare should likely target Insulin users, as they spend and claim significantly more for treatment than those using Metformin.

#8: Frequency of pharmacy claims
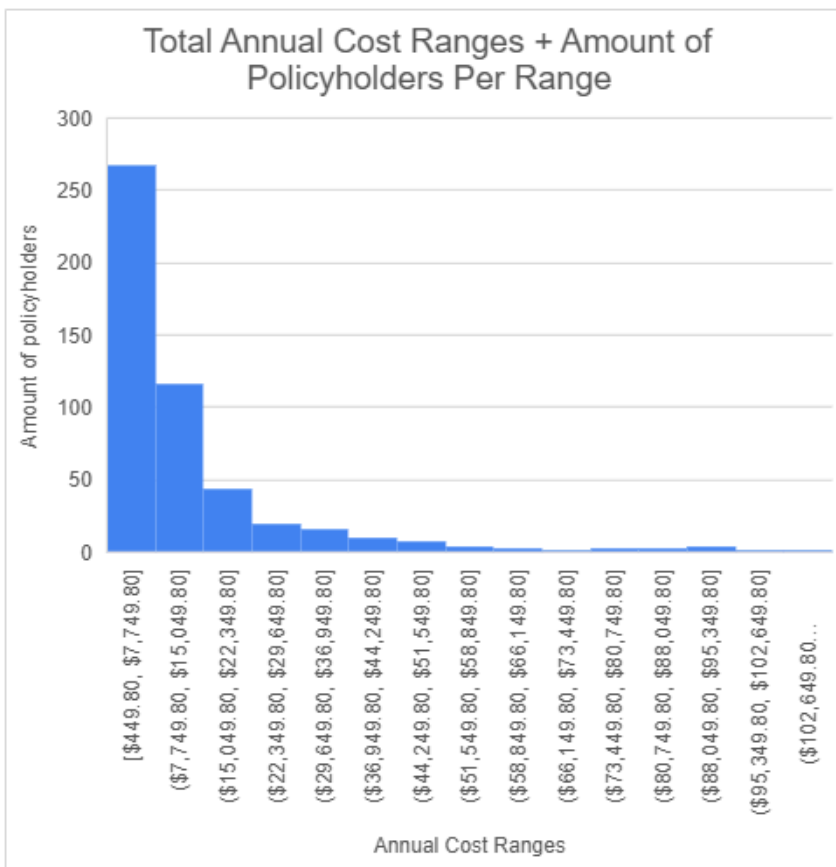
At least one claim: 67.4%
Both: 7.2% of total policyholders
Insulin: 11.8% of total policyholders
Metformin: 48.4% of total policyholders

This information allows Insuracare to pivot around offering incentives/funding for certain medications - such as Metformin - which appears to be prescribed often among diabetic policyholders.

#9: Creation of a data visualization


Insuracare should expect the most frequent total claim value to be within the range of $449.80 to $7,749.80. In general, the total claim values that Insurance covers will not exceed the range of $51,549.80 to $58,849.90, therefore they should be expecting to pay for ranges less than or equal to that range. Most of the policyholders incur a total annual cost less than the range of $51,549.80 to $58,849.90. There are about 400 or so policyholders who fit such a description.

We can tell by the logarithmic shape of the graph that as the annual cost increases, the frequency of policyholders who have higher annual costs sharply decreases. This is good because that means that there are significantly less policyholders who tend to have more extreme severity of financial loss.

Part 3: Mathematical Modeling *(Diabetes Topic Prompts)*

#10: Linear regression

Year vs. % of Diabetics in the US
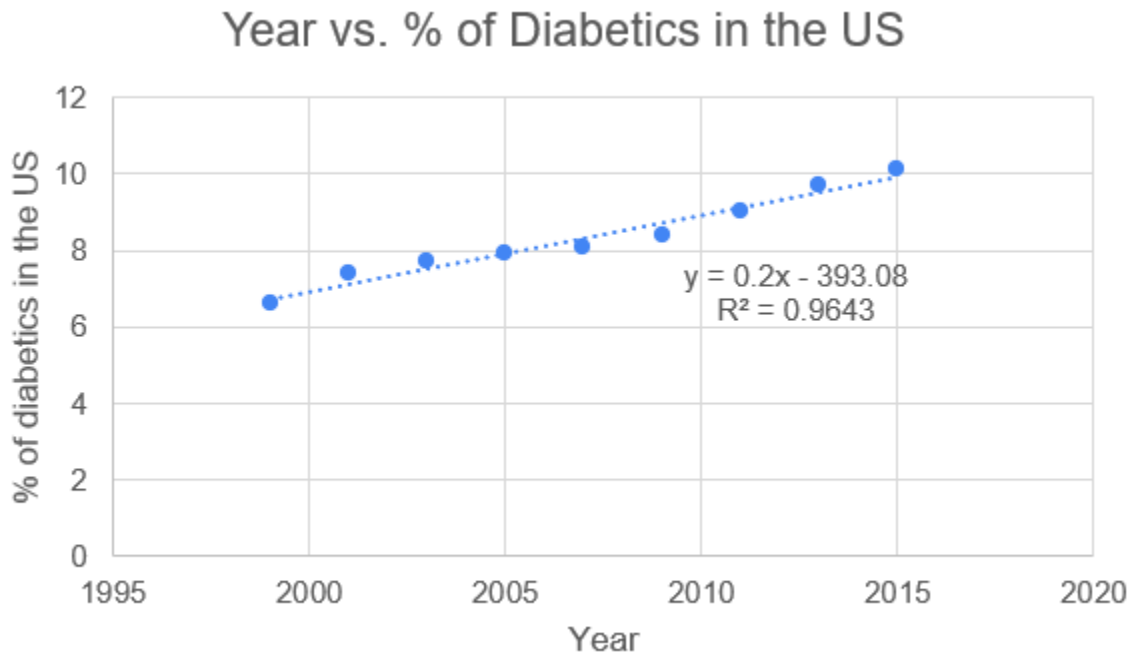
$$y = 0.2x - 393.08$$
$$R^2 = 0.9643$$

Equation: y = 0.2x - 393.08
R^2: 0.9643
R: 0.98198778

Since there is a high correlation coefficient, we can conclude that the regression is very reliable at predicting the trend for future values. The slope of the function (0.2) represents the growth over time. Each year, the percentage of the United States population with diabetes rises by 0.2%. This tells us that the United States is getting increasingly more susceptible to diabetes, significantly expanding the range of people who suffer from diabetes over time, and leaving many people susceptible to the condition.

#11: Compare projections
Our linear regression yielded 12.92% for the percentage of the US population with physician-diagnosed diabetes in 2030 which is 0.18% off from the CDC's projection. This slight deviation could be a result of several factors. First, we are only considering the general diabetic population growth over time. Because T1D and T2D have varying levels of genetic predisposition, the growth rates are difficult to predict. The CDC is also likely accounting for other factors, such as the climate change-induced growing hunger crisis which can raise diabetes diagnoses. However, these are factors we cannot account for by simply looking at the current trend.

#12: Expected value
If 11.3% of Insuracare's 500,000 policyholders are diagnosed with diabetes (making Insuracare have 56,500 diabetic policyholders), the expected value of total claims due to diabetes would be about $733,409,296.43.

#13: Assumption evaluation
Inflation is a reasonable assumption as it is relatively easy to calculate during a period of relative financial stability, especially after finishing all of the total calculations, so this assumption is unnecessary and it is

unrepresentative of what the company is likely to earn (as inflation will increase operating costs too, so why would it be factored in to our prediction?). The only issue with this approach is that it does not consider emergency situations like the pandemic where the inflation rate significantly rises, but this is going to hit every company anyway so it's better to at least consider the normal amount of inflation when considering the end of the projections.

#14: Assumption evaluation

The data of the 500 policyholders with diabetes is not a reasonable assumption because it isn't necessarily representative of all of Insuracare's diabetic policyholders. This data is only a portion of the whole which means that whatever done to it only represents that particular portion. Therefore, just because 500 policyholders have a certain trend going on, it doesn't mean that all of the policyholders will have the same trend as well. However, such an assumption may be necessary to understand the larger impact of diabetes policyholders on Insuracare, due to the fact that we lack other data and in order to grab plans of action from the dataset, we need (to some extent) to extrapolate the data such that it applies broadly among policyholders, making it a somewhat reasonable but absolutely justifiable assumption.
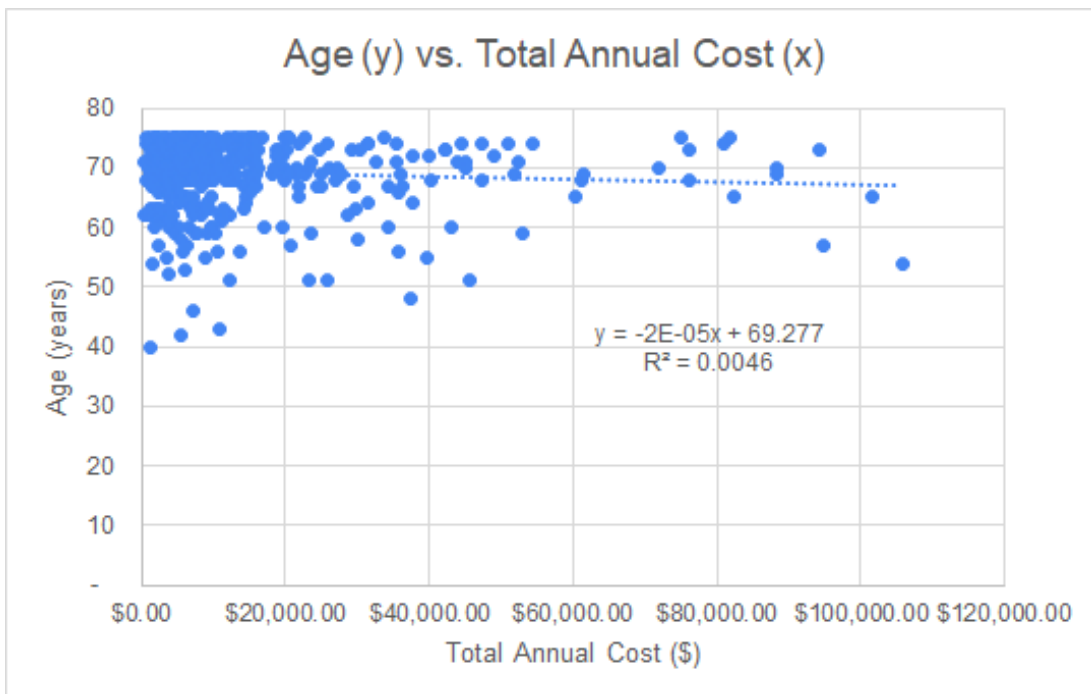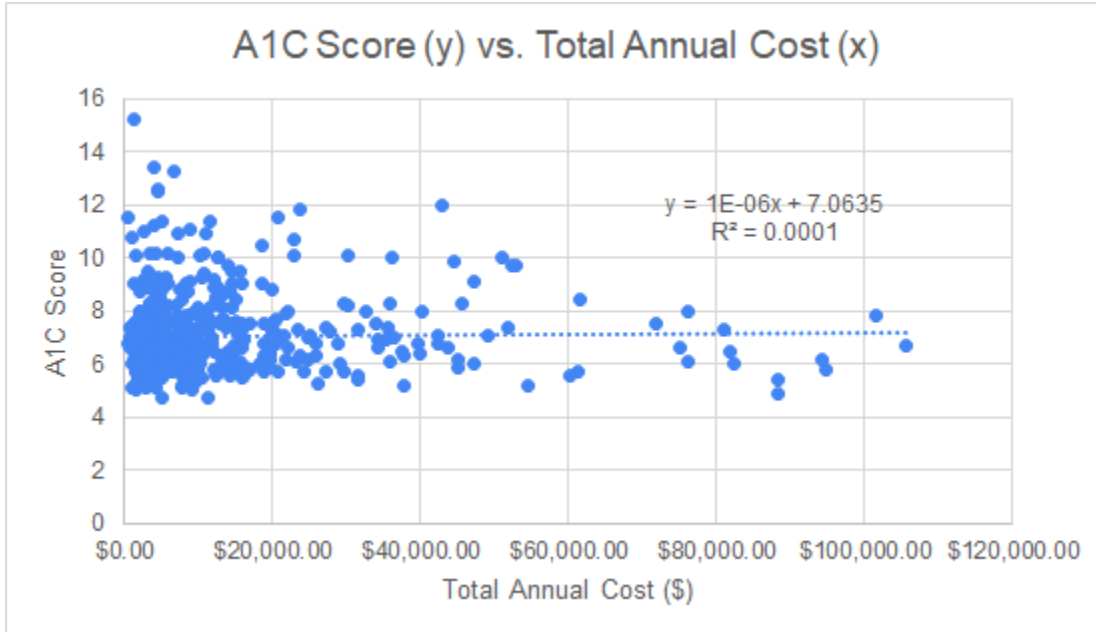
#15: Assumption evaluation

The assumption that Insuracare will continuously maintain 500,000 policyholders annually is justified by the fact that we have no data on how Insuracare specifically will expand in the future. Making this assumption would still allow for the scaling of loss assuming that our sample is representative of the population (an assumption we already determined as reasonable before).
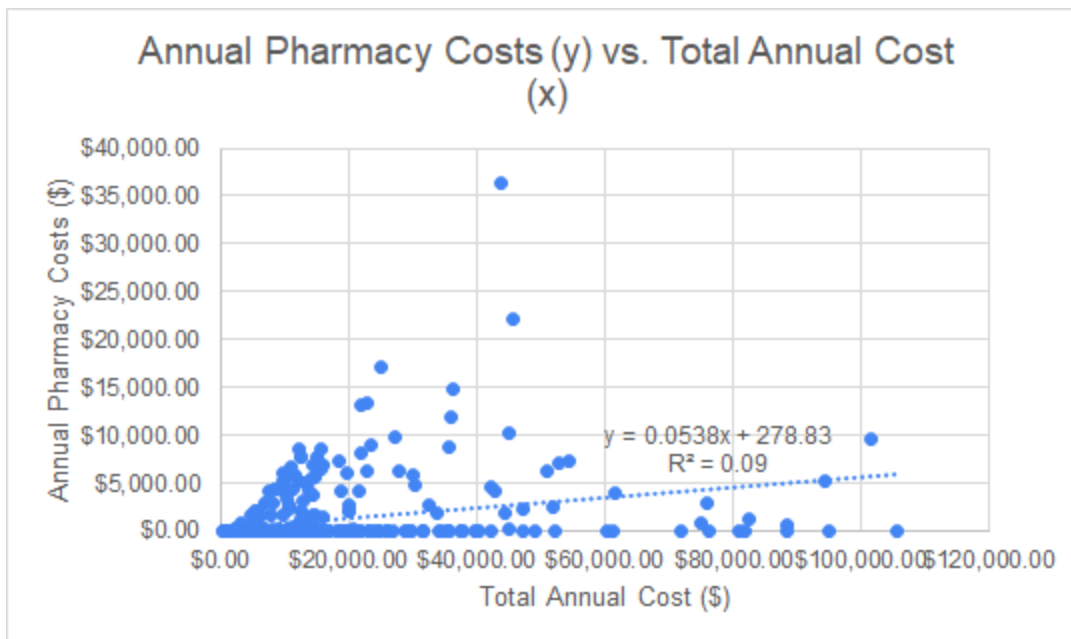
#16: Assumption evaluation

Assuming that Insuracare's services are offered nationwide, this is a fair assumption as it allows reasonable data to be used in the process of analyzing trends with diabetes on a larger scale independent of the market (assuming that Insuracare wants to grow and expand across the US). If Insuracare was only available at select locations in the US or it had special branches and unique deals for certain places, it would be more reasonable to track trends based on the demographics targeted by Insuracare.

Part 4: Risk Analysis *(Diabetes Topic Prompts)*

#17 Characterizing risk

A1C Score (y) vs. Total Annual Cost (x)

$y = 1E\text{-}06x + 7.0635$
$R^2 = 0.0001$

Axis label (y): A1C Score
Axis label (x): Total Annual Cost ($)

Age (y) vs. Total Annual Cost (x)

$y = -2E\text{-}05x + 69.277$
$R^2 = 0.0046$

Axis label (y): Age (years)
Axis label (x): Total Annual Cost ($)

Annual Pharmacy Costs (y) vs. Total Annual Cost (x)

$y = 0.0538x + 278.83$
$R^2 = 0.09$

A1C score, age, and annual pharmacy costs are all generally ineffective ways of predicting loss when measured against the total annual cost. When they are graphed versus Total Annual Cost (pharmacy claims + medical claims), the graphs produce negligible correlation results when analyzed using linear regression. The r^2 value tells us how close the line of fit adheres to the data (range from 0-1 where 1 is better). All r^2 values in the above graphs are at least below 0.1, which is rather low. This indicates that the line does not fit the data very well. Additionally, the slopes (coefficient of x) obtained by the regression are quite low. This tells us that even if the line would have fit the data, the effect of the attribute on the final response (Total Annual Cost) is generally negligible.

Out of all of the methods, the clear winner with the highest slope and the highest r^2 value is Annual Pharmacy Costs. However, this is still not an accurate method of predicting loss.

#18: Projecting expected value to 2030
We may assume:
- Insuracare will maintain 500K policyholders
- 13.1% of policyholders will have been diagnosed in the year 2030.

13.1% of policyholders * 500,000 total policyholders = 65,500 people diagnosed with Diabetes.
Average annual claim: $12,980.69
$12,980.69 average annual claim per person * 65,500 diabetic policyholders = $850,235,195 total predicted loss in 2030
The projected value of loss in the year 2030 is therefore estimated to be $850,235,195 USD.

#19: Current trajectory
Insuracare is projected to pay for more insurance by a significant amount if they do not act to reduce costs. For the current year, they are projected to have 56500 of diabetic policyholders, totaling in about $733,409,296.43 worth of claims. However, according to the projection until 2030, Insuracare will have to pay $850,235,195 worth of claims. That is an extra $116,825,899 that Insuracare is paying.

#20: Considering pharmacy claim reasons
There are several reasons a diabetic policyholder on medication may not choose to claim, one being because they are opting to save their claims for medical treatment (counseling, therapy, etc.) rather than medications. For

those who are not taking either medication, they may not have pharmacy claims because Insuracare does not cover the particular medication they are taking. Additionally, they may determine certain medications as not medically necessarily. Diabetic policyholders on both Insulin and metformin may not have pharmacy claims because Insuracare does not support the pharmacy that the policyholder is attempting to receive medication from (outside of their insurance network).

#21: Assessing incentivization strategy
No, Insuracare should not be incentivizing certain medicines when it goes against the doctor's recommendation. However, for those who can take both metformin and insulin safely and per the doctor's recommendation, it would obviously be in the patient's best interest to pick metformin. However, this should be a decision made by the patient's doctor in accordance with Insuracare policy. By working with healthcare professionals, Insuracare can ensure that patients get the best medication they can at the prices they can afford.

Part 5: Recommendations *(Diabetes Topic Prompts)*

#22: Cost of the mitigation strategy
Out of 500,000 members in Insuracare, 13.1% have diabetes.
0.131*500000 = 65500 diabetes policyholders
Out of those who have diabetes, 10% of them will participate
0.1 * 65500 = 6550 diabetes policyholders who participate in the DSMES incentivization program
12 vouches * $20 per voucher = $240 per policyholder paid in vouches
$240 * 6550 policyholders = $1,572,000 total cost.

Therefore, the mitigation strategy will cost $1,572,000 to implement.

#23: Expected value of loss with the mitigation strategy
$6,490,347.76 = total annual claims
0.95 * $6,490,347.76 = $6,165,830.37 expected value of loss of claims alone
12980.6955 -> 12331.6607 (after 5% reduction)
$6,165,830.37 + $1,572,000 = $7,737,830.37 expected value of loss with implementation of the program

Therefore, when considering the reduction in loss due to the implementation of the program and its cost of installation, the total cost comes out to $7,737,830.37 USD.

#24: Difference between mitigation and current trajectory
$7,737,830.37 - $6,490,347.76 = $1,247,482.61 additional loss after implementation of the mitigation strategy.

This essentially means that to implement the program through the voucher method, Insuracare would lose a significant amount of money (more than $1.2 million USD). Ultimately, this attempt at mitigation is ineffective in the long term.

#25: Evaluating if the strategy should be recommended
Although educating people with diabetes is important, the vouchers end up costing Insuracare far more than it would be worth to implement. Insuracare should look into alternative forms of incentivization to ensure that these patients go to these classes (as it will lead to health benefits) while not requiring an absurd amount of money to force attendance.