# MTECH KE5106

# DATA WAREHOUSING FOR BUSINESS ANALYTICS

# PROJECT REPORT

**Factors Affecting Medical Expenses in Singapore**

**TEAM MEMBERS**

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# 1.0 INTRODUCTION

Healthcare costs are rapidly rising as Singapore population ages, several developments such as prevalent chronic conditions and excess demand for healthcare services continue to drive the upward trend in healthcare expenses today. According to Ministry of Health, the inflation rate for Singapore's average annual healthcare was 2.4 per cent between 2011 and 2018 [1]. More specifically, the gross medical inflation rate stood as high as 10% in the year of 2017, exceeding the global rate where it was at 8.4%. Recently, the healthcare insurer, AON [2], predicted that healthcare costs would increase more rapidly in Singapore than in many other countries in the region.

As a result, Singapore government expenditure on healthcare was expected to "rise quite sharply" in the upcoming years as stated by the Ministry of Finance. In fact, the total budget for the Ministry of Health (MOH) was increased to $10 billion [3] in the year of 2018, doubled from that of the year of 2010, which was $4 billion [4]. The MOH budget will have another sharp increase of $3 billion by 2020.

While it is not possible to stop medical costs from hitting the record-high level, policy makers can effectively temper the impact of increasing cost by introducing early interventions, care management and proactive engagement with stakeholders. Therefore, it is important to understand what drives healthcare costs in Singapore. In this study, we conducted exploratory analysis of factors accountable for medical expenses in Singapore, hoping to provide meaningful insights to MOH and help keep healthcare costs sustainable.

The rest of the report is organizes as follows, we first define the scope of the study, followed by data collection methods and data processing approach. Next, we presented data analytics, visualization and the dashboard. Lastly, we concluded with key findings and recommendations.

# 2.0 SCOPE OF THE STUDY

This study explores and examines determining factors, focusing on three aspects such as demographics, physical conditions, and medical history and symptoms that affect the medical expenses in Singapore. We aim to provide insights to policy makers at Ministry of Health and Ministry of Finance, and help them with managing the rising medical expenses in Singapore.

## 3.0 DATA COLLECTION

Medical data such as hospital bill amount for each patient identified by ID, anonymous medical history records, symptoms and lab results, weight and height were obtained from government open data sources such as data.gov.sg.

## 4.0 TECHNICAL APPROACH

The collected medical data such as hospital bill amount for each patient identified by ID, anonymous medical history records, symptoms and lab results, weight and height. The raw data was imported into Microsoft SQL Server database. The entity relationship (ER) diagram of the data is presented in Figure 1 as follows.

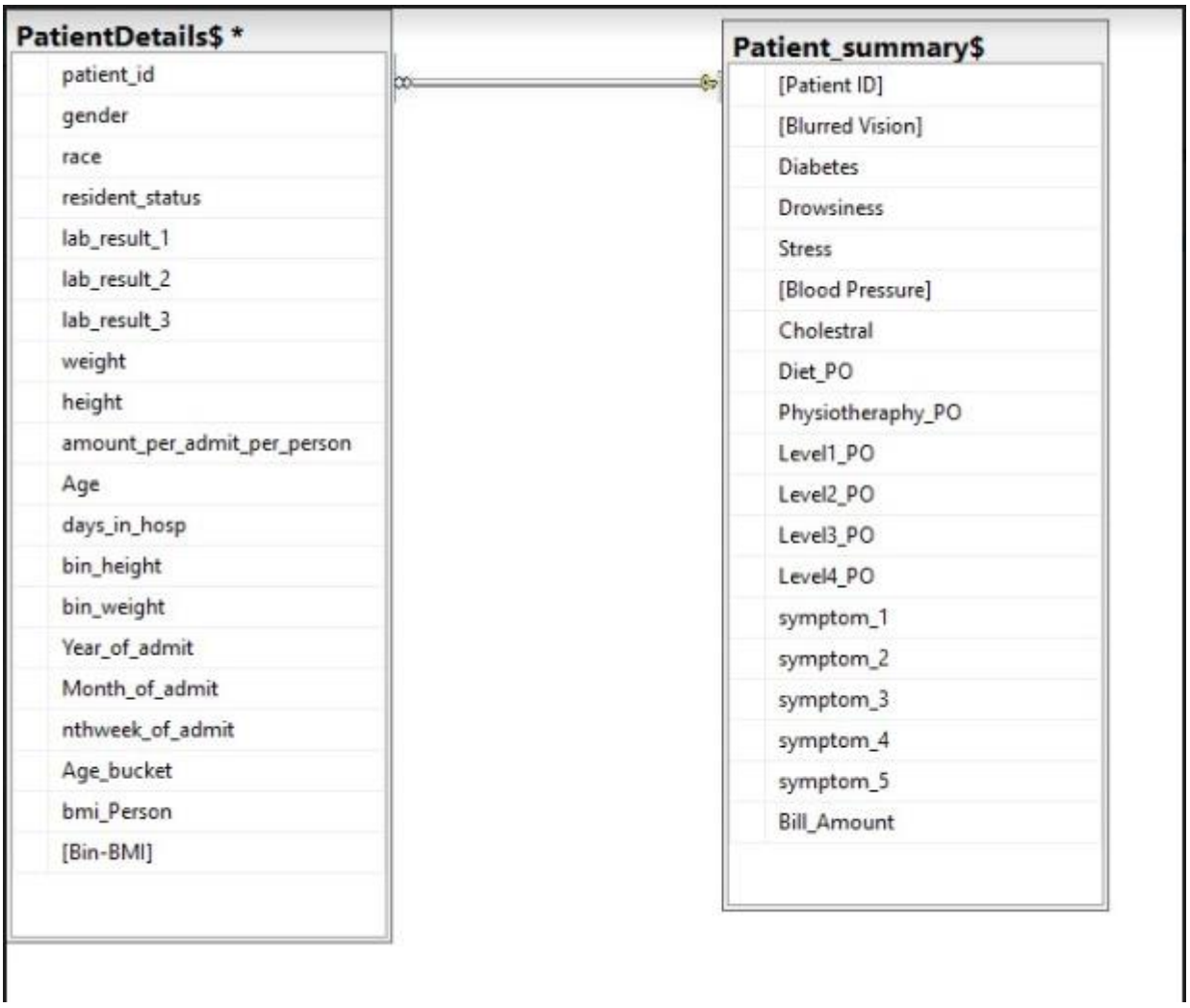



Figure 1: Entity Relationship (ER) Diagram

The ER diagram consists of two tables, Patient Details and Patients Summary. The relationship between the Patient Details and Patients Summary is one-to-one. The database schema is shown in Figure 1.

The resultant database schema consists of Patient Details and Patients Summary table with Patient ID (foreign key) referencing the primary key (Patient ID) of Patients details table.

**Data Cleansing**

We have also used Microsoft SQL to cleanse the data. The cleansing techniques we have used are as follows.

1. Left Join of the two tables.

2. Imputing of null values

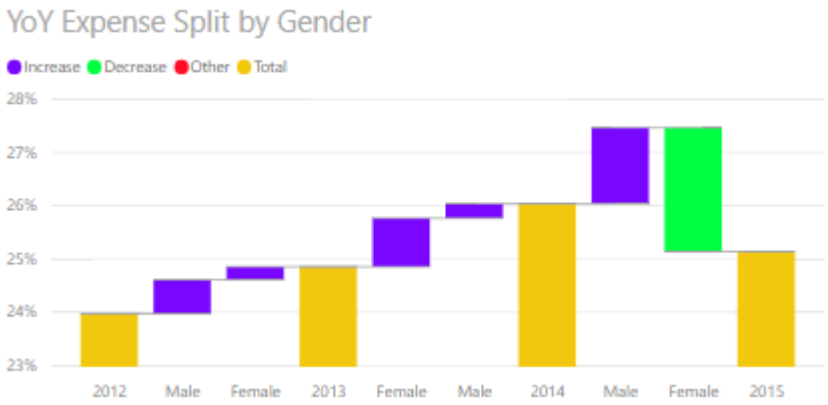
3. Calculation of BMI, Age Buckets and BMI Buckets.

## 5.0 ANALYTICS

We conducted exploratory analysis to understand the relationships between gender, age, ethnic groups, body mass index (BMI), medical history, symptoms and medical expenses. Accordingly, the following metrics were applied to fulfil the purpose of the analysis.

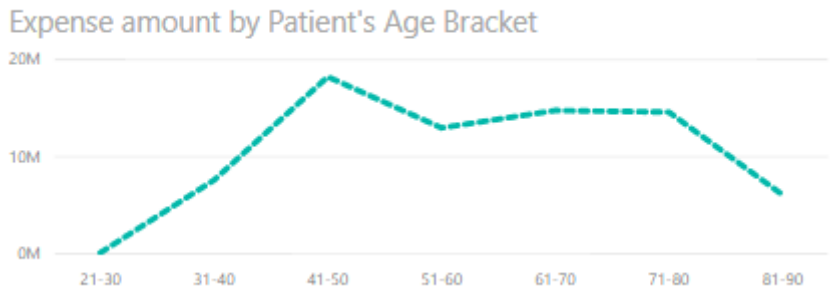
- Medical expenditure based on Gender
- Patients' BMI categories (BMI = Weight in Kg / Height * Height in meters)
- Medical expense based on Gender and Ethnic Groups
- Medical expenses based on medical history and medical symptoms

### 1. Medical expenses based on Gender




The medical expenses from 2012 to 2015 had a constantly slight upward trend. On the gender basis, the amount incurred had been a constant rise for the male, whereas there was a decrease for the female. More over there is a sharp fall in the year 2014 for the female. The analysis showed that medical costs for men were higher than those of women.

## 2. Hospital Expense by age group




The Histogram above showed the amount spent by all age groups of patients who were admitted to the hospital. The maximum number of patients was within the age group of 41-50, especially for those aged from 42 to 45 (see Table 1). This highlights that if we treat the patients with proper medication or making the people understand the importance of leading a healthy life style at an earlier age can avoid disease at old age.

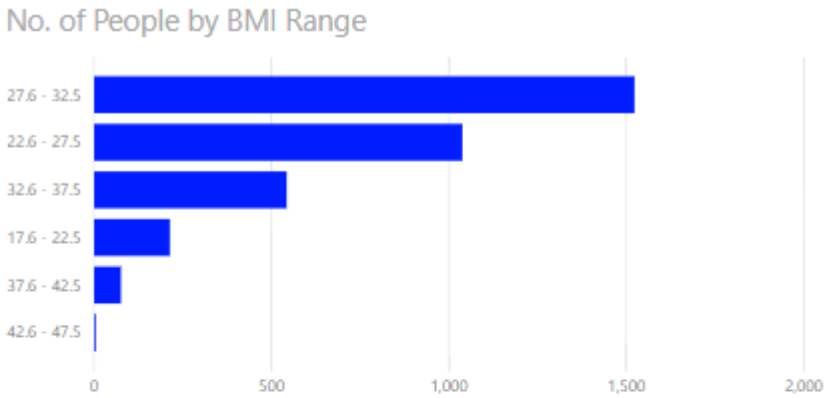
| Age | Expense |
|---|---|
| 41 - 50 | 18 Million |
| 61 - 70 | 15 Million |

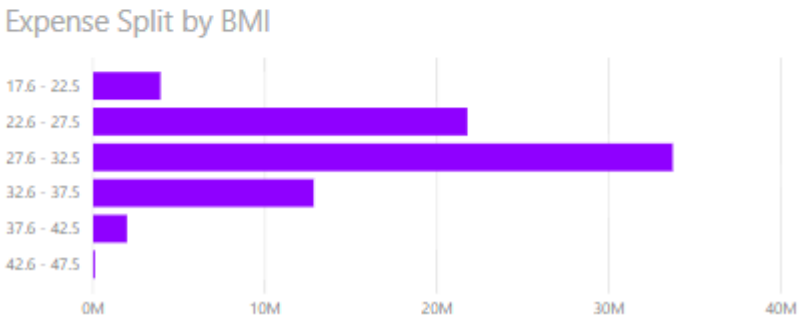
Table 1: Hospital Admission by Age, 42 to 45

## 3. BMI categories

Overall, the patients' BMI ranged from 17.51 to 46.68 with an average of 28.96, which was falling into the 'Overweight' category'. It showed that more than 50% of the sample

belonged to either Overweight or Obesity category. The BMI categories were provided in Table 2.

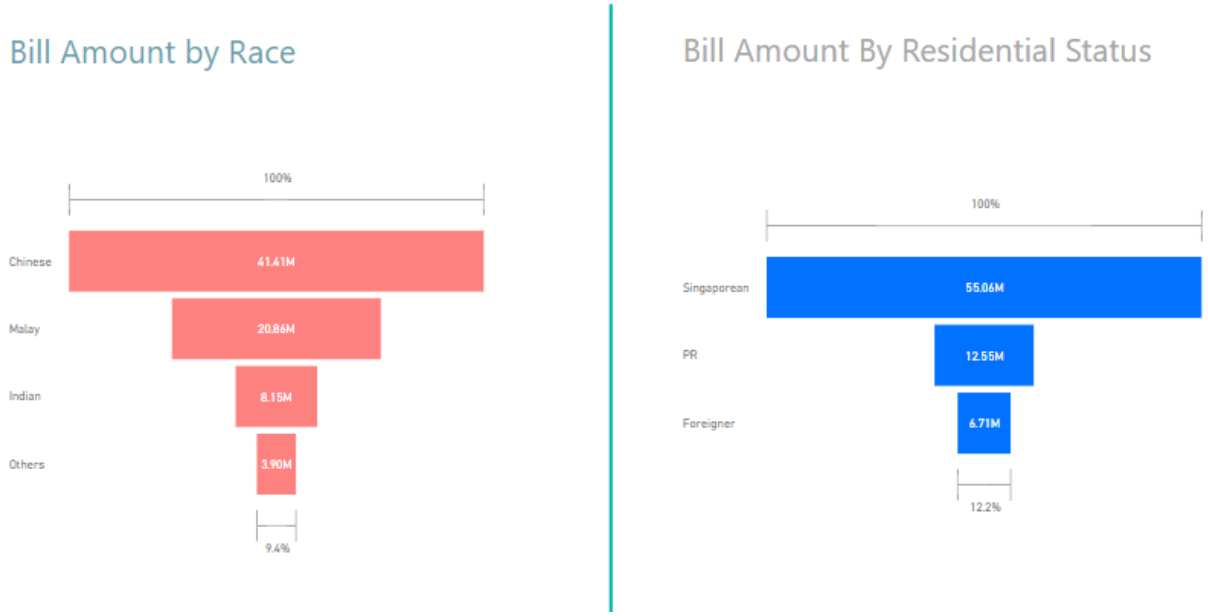



| BMI Index range | Count | Health Condition |
|---|---|---|
| 17.6-22.5 | 214 | Healthy Weight |
| 22.6-27.5 | 1038 | Healthy Weight |
| 27.6-32.5 | 1523 | Overweight |
| 32.6-37.5 | 543 | Obesity |
| 37.6-42.5 | 76 | Obesity |
| 42.5-47.5 | 5 | Obesity |

Table 2: BMI Categories

## 4. Medical expenses based on Residential Status and Ethnic Groups



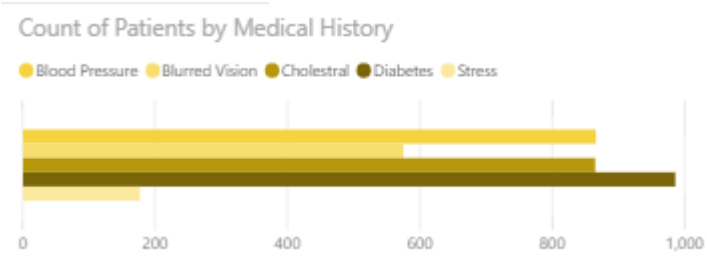

| Race | Amount |
|---|---|
| Chinese | 41.41 M |
| Malay | 20.86 M |
| Indian | 8.15 M |

| Residential Status | Amount |
|---|---|
| Singaporean | 55.06 M |
| PR | 12.55 M |
| Foreigner | 6.71 M |

Table 3: Medical expenses based on race and residential status

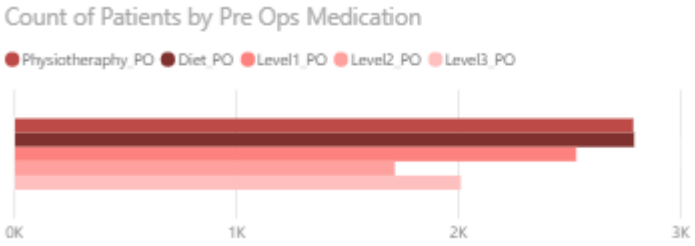
The graphs above and Table 3 present the overall medical expenses based on gender and ethnic groups. It seemed that the Malay group had relatively high medical expenses. The reason we put them ahead of the Chinese is due to the fact that they are not even 25% of the Chinese population.

## 5. Medical history analysis



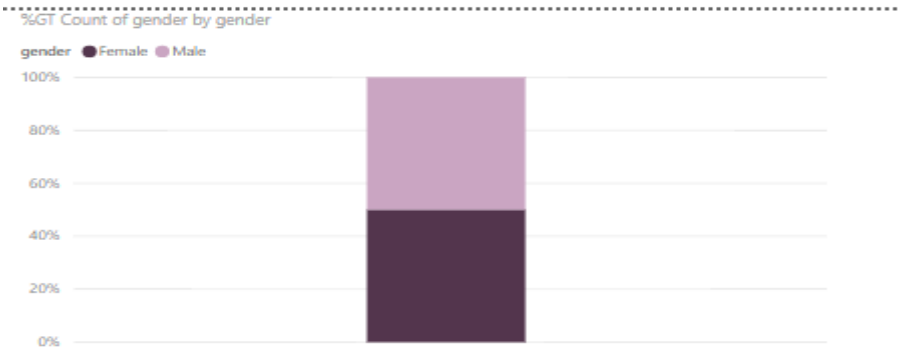

The graph shows that patients who have Diabetes, Cholestral and Blood Pressure at an early age are prone to major health issues at old age. Since these conditions are mainly due to the life style and food habits, a proper guidance at an early age can prevent this.

## 6. Pre Op Medication analysis



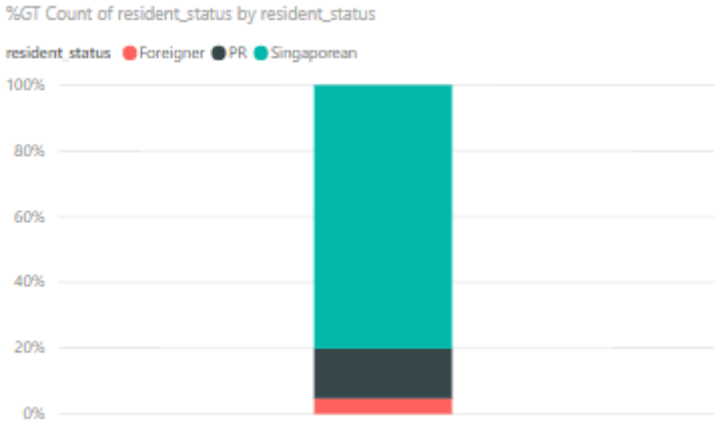

Per op medication is something which is given to patients before suggesting them a next level specialised treatment. It can be clearly seen that without proper pre opt medication suggestions, most of the people end up being patients. The three stand out factors are Diet, Physiotheraphy and Level 1 PO, which suggests that without proper diagnosis these 3 pre ops are being suggested to patients in general. Hence a proper pre diagnosis will help to avoid major diseases at an older age.

## 7. Breakdown of the Sample by Gender



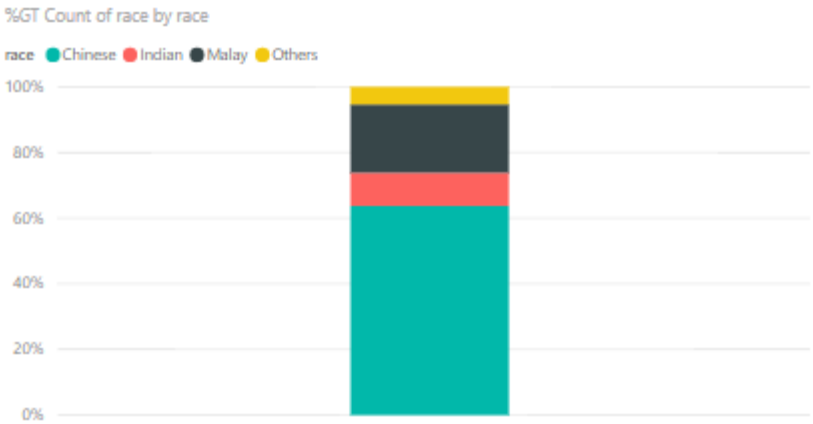
- 49.94% are male
- 50.06% are female

## 8. Breakdown of the Sample by Residential Status




- 80.12% are Singaporean
- 15.5% are Singapore PR holder
- 4.74% are Foreigners

## 9. Breakdown of the Sample by Ethnic Groups




- 63.71% are Chinese
- 20.79% are Malay
- 10.12% are Indians
- 5.38% are Others

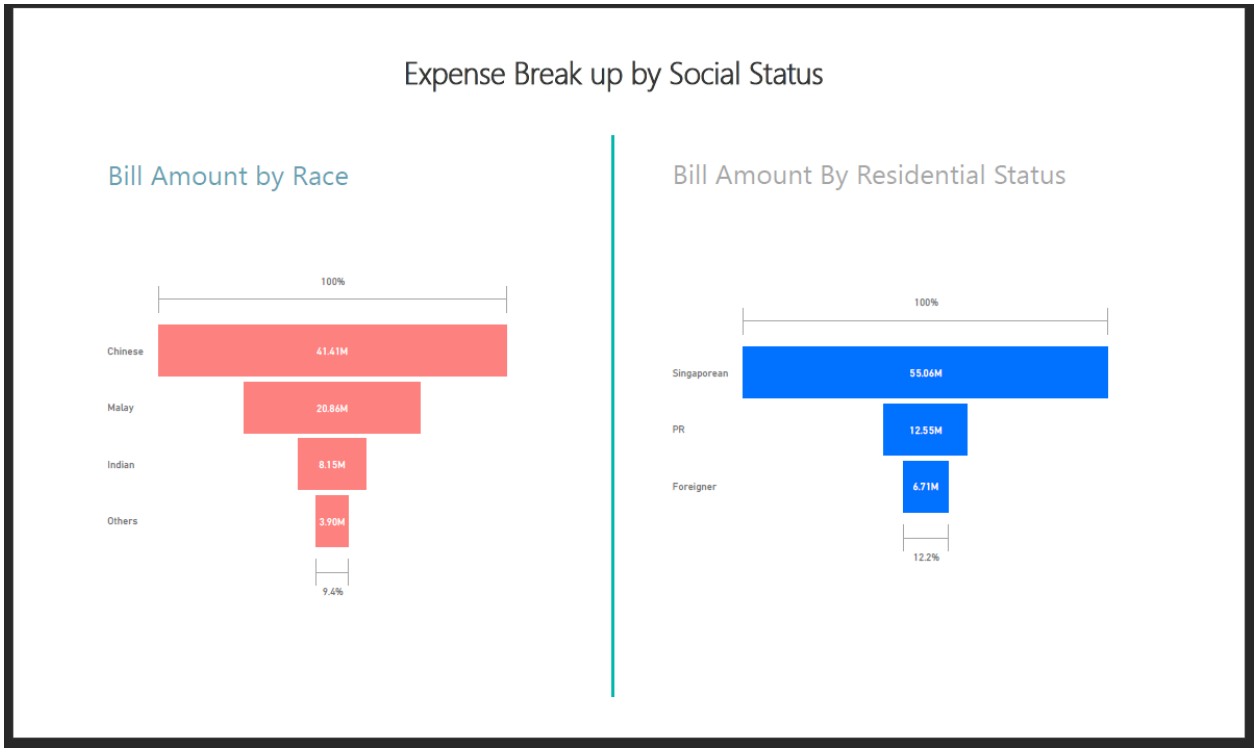
## 6.0 DASHBOARD DESIGN

The dashboard portrays various metrics used in the exploratory analysis and provides an overview for users such as policy makers. More specifically,

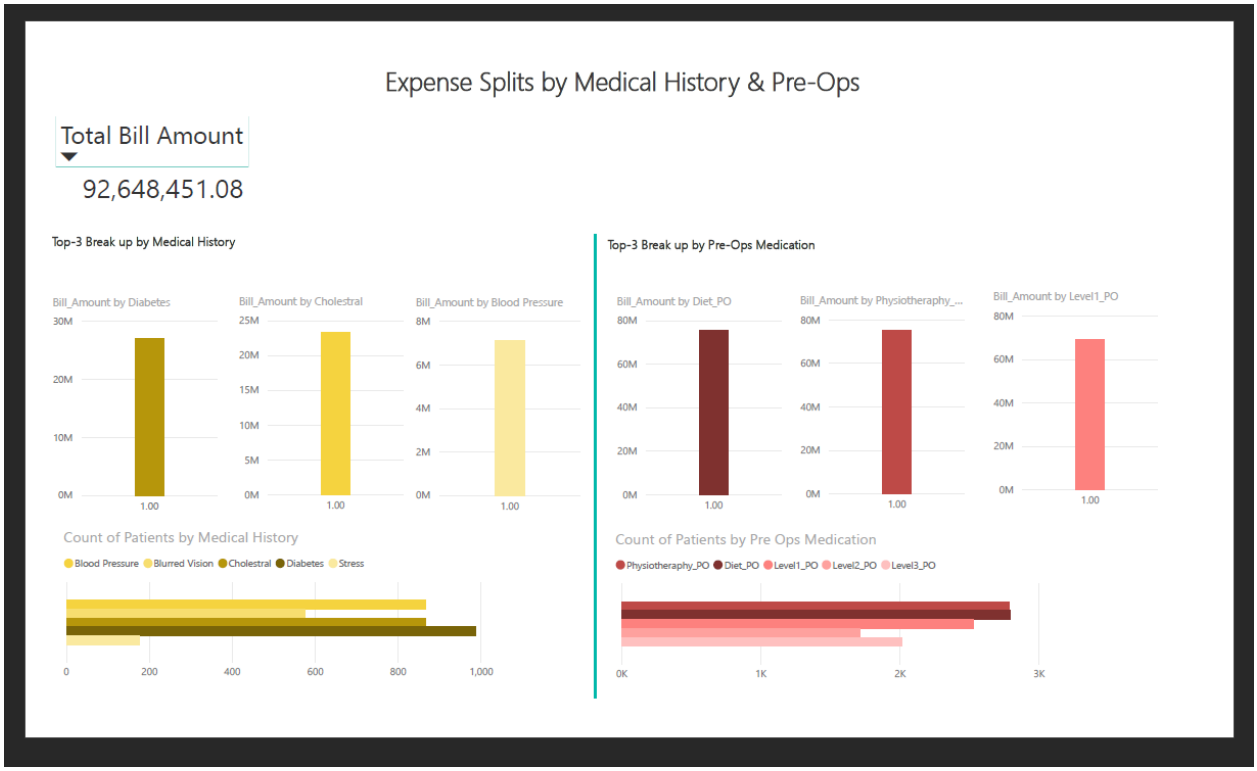
- Dashboard 1 indicates the relationship between medical expenses and patients' medical history and major pre op medication causing diseases.
- Dashboard 2 shows medical expenses based Gender, Age and BMI. In recent years, medical expenses by male patients had increased while that of female had a decreasing trend. Also, those who were aged from 41 to 50 had a higher medical cost than the rest. In addition, overweight people had spent more on medical expenses.
- Dashboard 3, shows the medical expenses by race and residential status..

By interpreting the information from the dashboard, measures and remedies can be taken to curb the medical expenses and introduce more efficient ways of managing medical resources and proactive measurements for preventive care.


Dashboard 1: Medical expenses based on Gender, Age and BMI




Dashboard 2: Medical expenses based on Ethnic Groups and Residential Status




Dashboard 3: Medical expenses based on medical history and pre op medications

## 7.0 CONCLUSION

This study stated the impact of age, gender, ethnic groups, BMI, medical history and symptoms on medical expenses. Based on the information, necessary measures can be taken in order to reduce future inflations in medical costs of Singapore.

## 8.0 REFERENCES

[1] Ministry of Health Singapore. (2018). Retrieved from https://www.moh.gov.sg/content/moh_web/home/pressRoom/Parliamentary_QA/2018/healthcare-cost-inflation-.html.

[2] Baker, J. A. (2018). Singapore ranks high in report on medical inflation in Asia. Retrieved from https://www.channelnewsasia.com/news/singapore/medical-hospital-costs-singapore-inflation-aon-10112896.

[3] Tan, A. (2018). Singapore Budget 2018: Spending needs to grow in healthcare, infrastructure, security and education. Retrieved from https://www.businesstimes.com.sg/government-economy/singapore-budget-2018/singapore-budget-2018-spending-needs-to-grow-in-healthcare.

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