IS SINGAPORE HEALTHCARE GETTING BETTER OVER THE YEARS?

Wong Qi Yuan, Jeffrey
Introduction to Programming for Data Science
Specialist Diploma in Data Science (Predictive Analytics)

Overview

- We will be exploring if Singapore's healthcare is indeed getting better quantitatively.
- We will be using a few datasets obtained from Singapore's open data portal, and open data sources from the World Bank to obtain data of other countries' healthcare performance.
- A set of data analysis tools from the **Pandas**, the **Matplotlib Library** as well as **Seaborn library** will be used to visualize our given data and to show the time series changes in our data.
- The outcome from this research will show that there are indeed some extend of positive improvements in healthcare over the years in Singapore and will be explained further on next few slides.

Introduction

- Singapore prides herself to have one of the best healthcare system in the world. Our healthcare system is currently ranked 2nd in the world in **Bloomberg's Healthcare Efficiency report 2018** and **6th for Overall Healthcare System Performance by WHO**.
- Such comparisons and rankings are based on relative metrics among different countries.
- **In this study, we will analyses if Singapore's healthcare system is getting better on absolute terms, and determine areas for improvement and also if Singapore's healthcare is getting more affordable than in the past.**

1) Cost of SG Healthcare

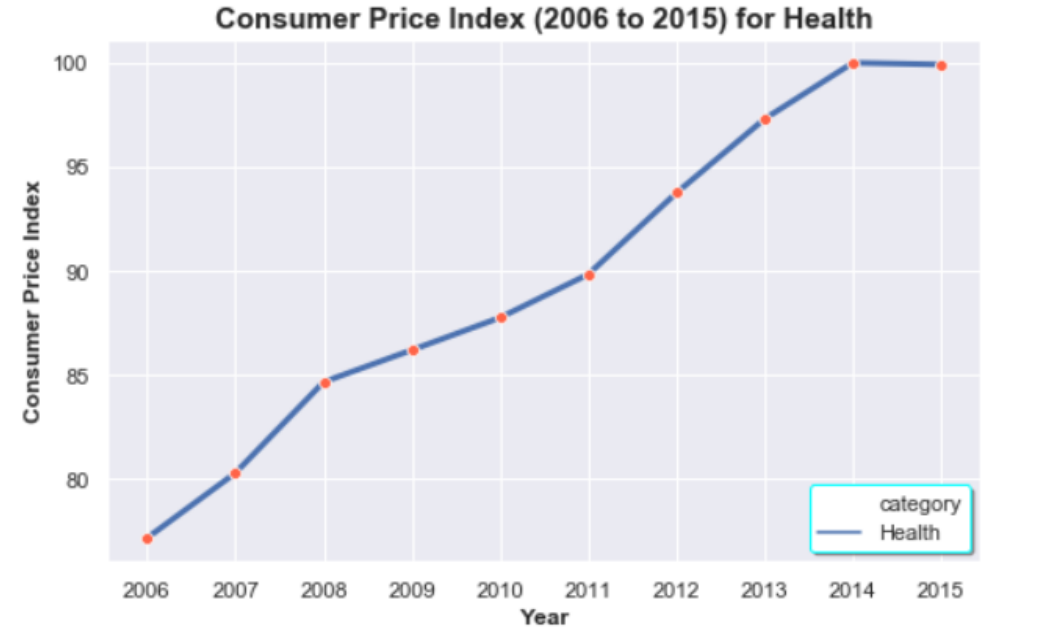
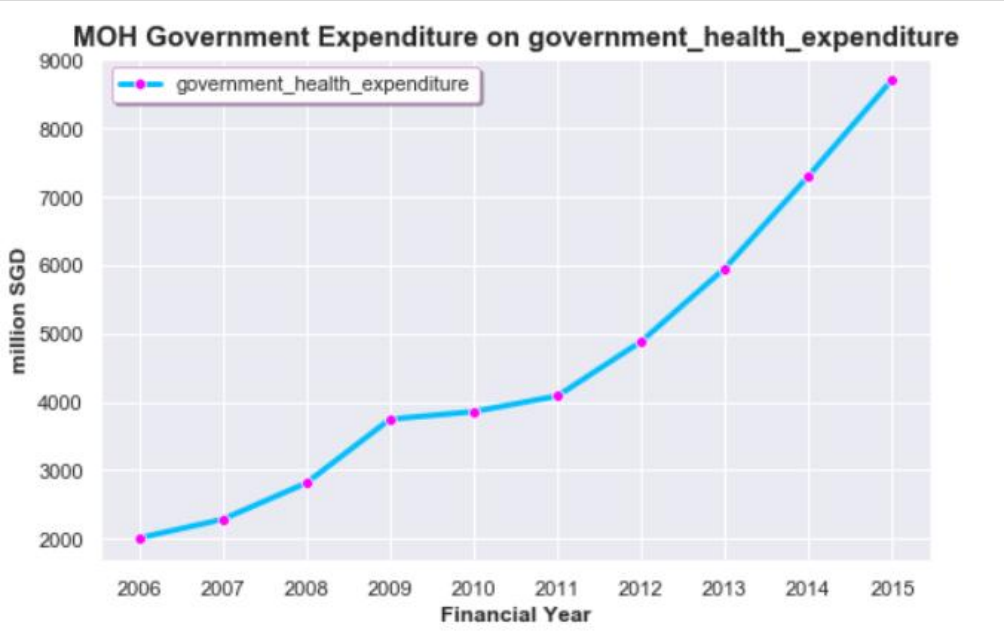


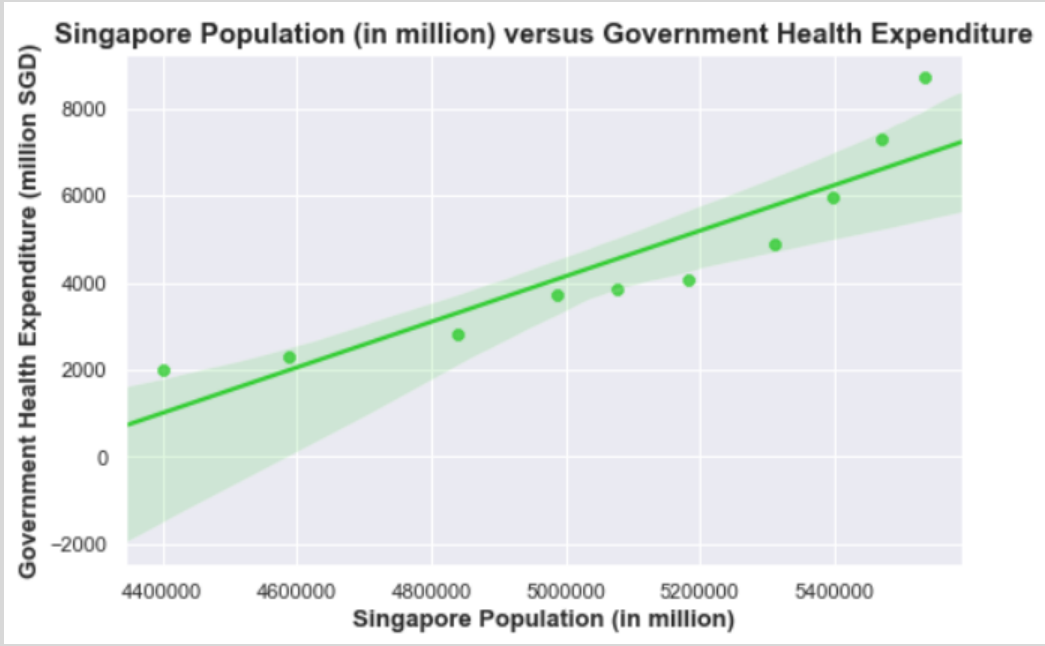
Table of Data for Health category:

	year	category	cpi
0	2006	Health	77.148
1	2007	Health	80.270
2	2008	Health	84.641
3	2009	Health	86.176
4	2010	Health	87.733
5	2011	Health	89.814
6	2012	Health	93.730
7	2013	Health	97.285
8	2014	Health	99.979
9	2015	Health	99.895

- Based on the chart shown above, the Consumer Price Index has risen by about 15% from 2006 to 2014.
- The rise in prices were rapidly initially from 2006 to 2008 and from 2011 to 2014 as seen in the steep rise in the graph during these periods.
- However, there are optimistic signs that the healthcare costs are still under control by the government as the Consumer Price Index fell in 2015 from 2014.

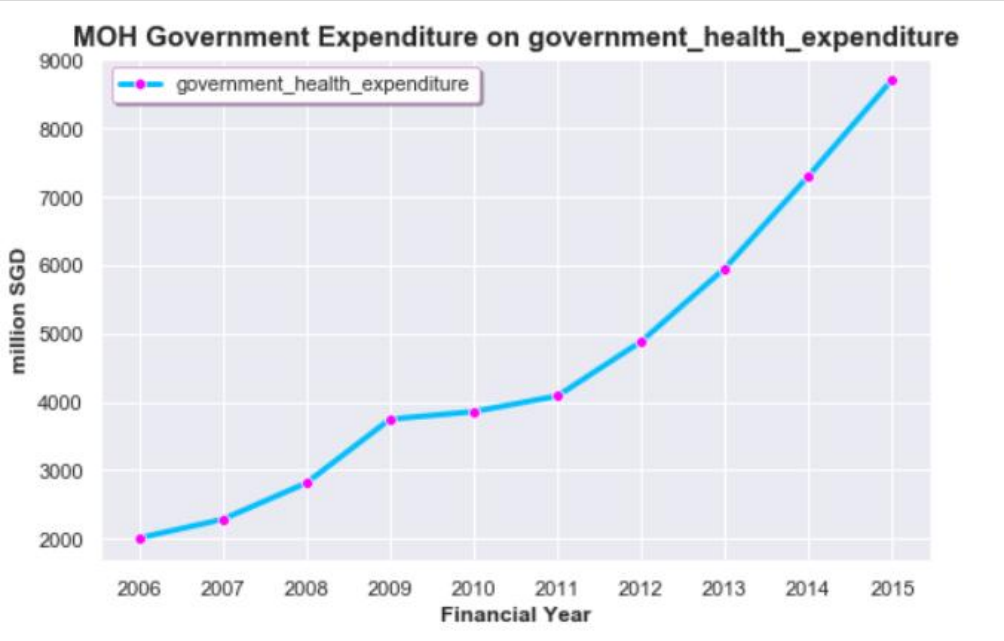
2) Government Expenditure

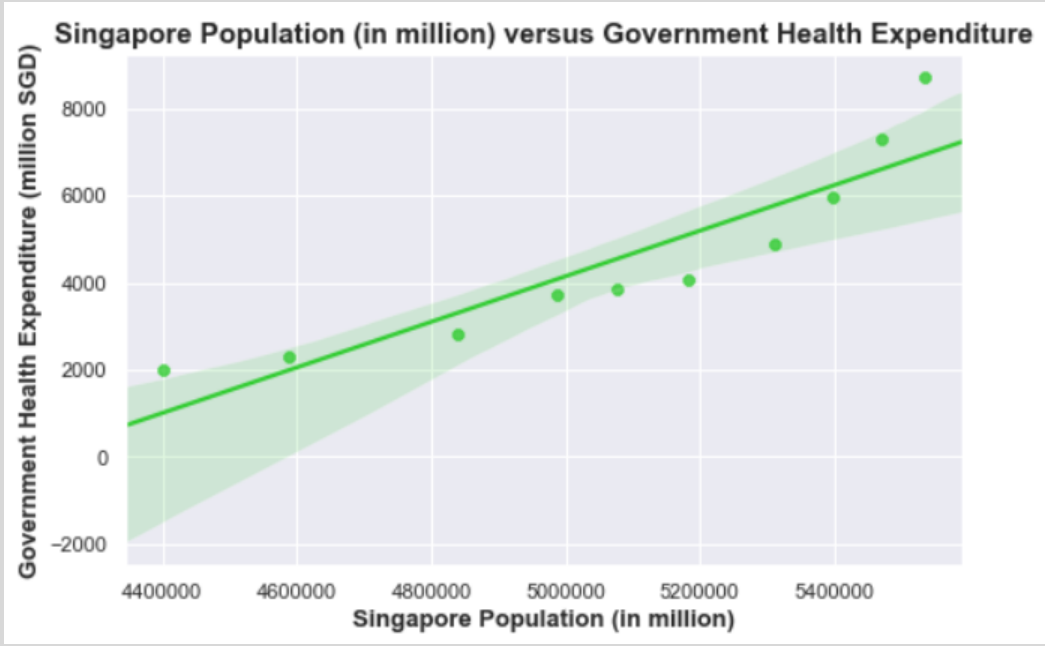




- As a measure of the level of importance the government places on healthcare, we shall study the amount of resources (i.e. money) the government spends on healthcare.
- As shown in the chart above (left), the government is spending more resources on healthcare., and the figures are rising exponentially in recent years.
- This reflects the effort the government puts in on improving healthcare for Singaporeans.
- Since the government has been put in great concern on Singapore's healthcare, we will determine if the government health expenditure correlates with increasing Singapore Population over the years.

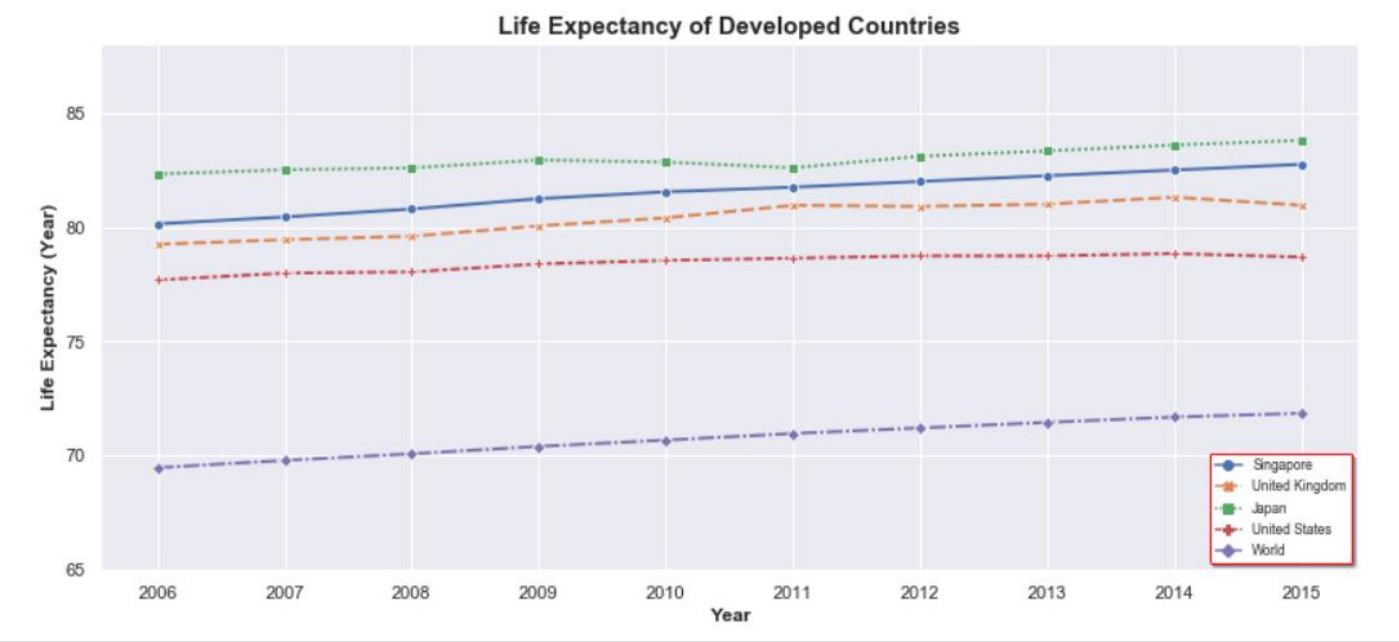
2) Government Expenditure





- As shown in the chart above (right), we can see that there is a strong positive association between Singapore Population (in million) and Government Health Expenditure (in million SGD).
- In additionally, we can also be proven that there is a strong positive linear correlation between Singapore Population (in million) and Government Health Expenditure(in million SGD) as r = 0.909170.
- Next, we will determine if the greater emphasis placed on good healthcare indeed correlates with better health for Singaporeans.

3) Quality of Health



Data for World Life Expectancy from 2006 to 2015:

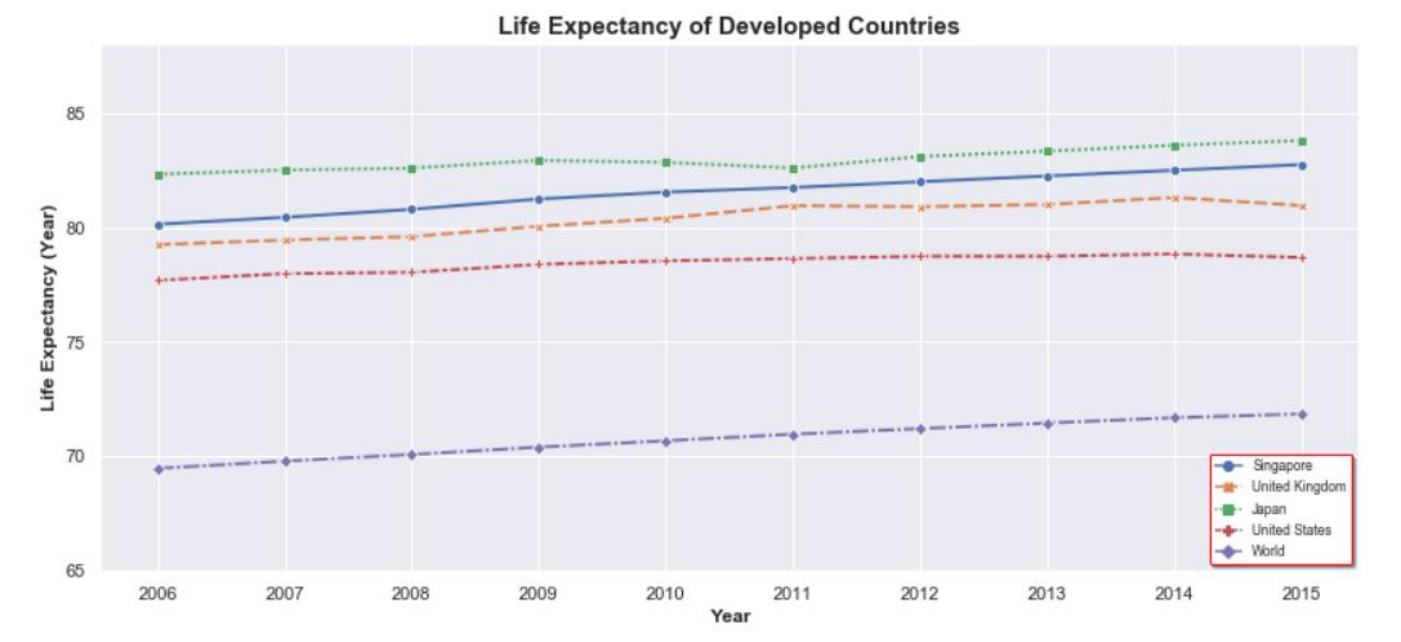
Country Name	Singapore	United Kingdom	Japan	United States	World
2006	80.141463	79.248780	82.321951	77.687805	69.482104
2007	80.441463	79.448780	82.507073	77.987805	69.800753
2008	80.790244	79.600000	82.587561	78.039024	70.089265
2009	81.241463	80.051220	82.931463	78.390244	70.410950
2010	81.541463	80.402439	82.842683	78.541463	70.687492
2011	81.743902	80.951220	82.591220	78.641463	70.975621
2012	81.995122	80.904878	83.096098	78.741463	71.218908
2013	82.246341	81.004878	83.331951	78.741463	71.462730
2014	82.495122	81.304878	83.587805	78.841463	71.695508
2015	82.743902	80.956098	83.793902	78.690244	71.858726

Basic Descriptive Statistics Summary for World Life Expectancy:

Country Name	Singapore	United Kingdom	Japan	United States	World
count	10.000000	10.000000	10.000000	10.000000	10.000000
mean	81.538049	80.387317	82.959171	78.430244	70.768206
std	0.877064	0.748542	0.488528	0.392856	0.813959
min	80.141463	79.248780	82.321951	77.687805	69.482104
25%	80.903049	79.712805	82.588476	78.126829	70.169686
50%	81.642683	80.653659	82.887073	78.591463	70.831557
75%	82.183537	80.954878	83.272988	78.728659	71.401774
max	82.743902	81.304878	83.793902	78.841463	71.858726

- To find out if healthcare is improving to help people in Singapore live a longer and better life, we will study the life expectancy rates and the mortality rates of people with different common chronic diseases.
- We will also be comparing the life expectancy rates with common developed countries.

3) Quality of Health



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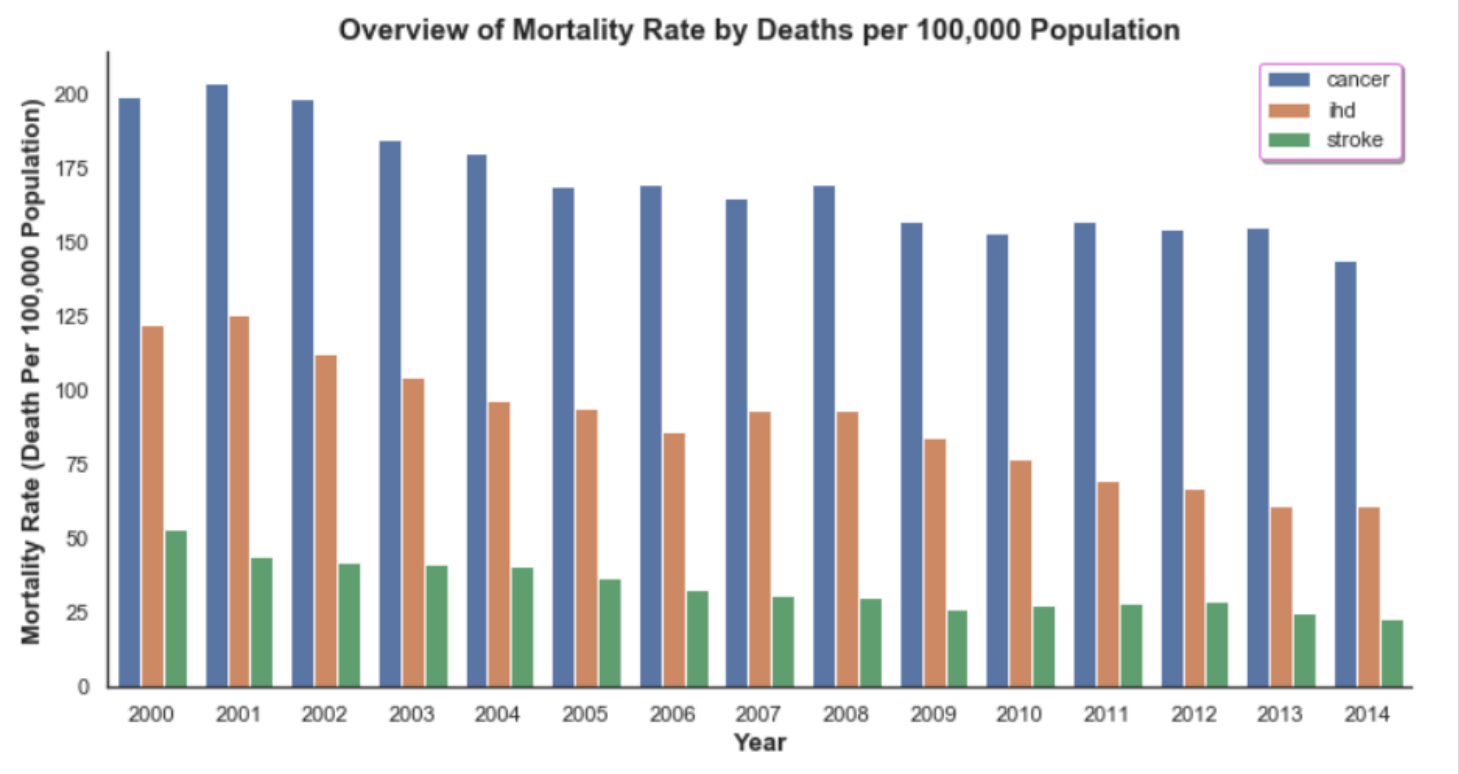
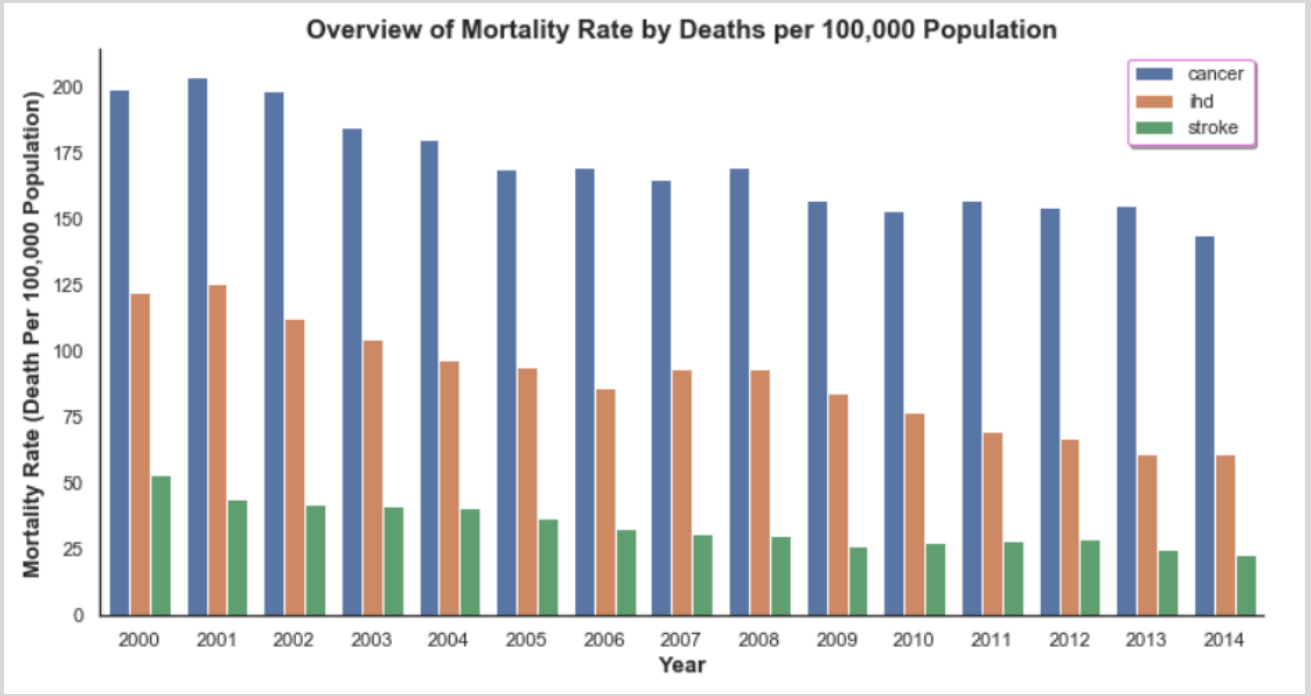
- From the graph above, an average Singapore evidently living longer than an average person around the world.
- Singaporeans also have a comparable life, if not better, life expectancy than some developed countries.
- However, living longer cannot be a definite statement for good quality of life and health. A person may be living longer, but plagued with chronic diseases.
- On the other hand, it may be hint that there are advanced in modern medicine to increase the lives of these patients, hence allowing life expectancy to be a measure of better over healthcare.

4) Mortality Rates due to Chronic Diseases



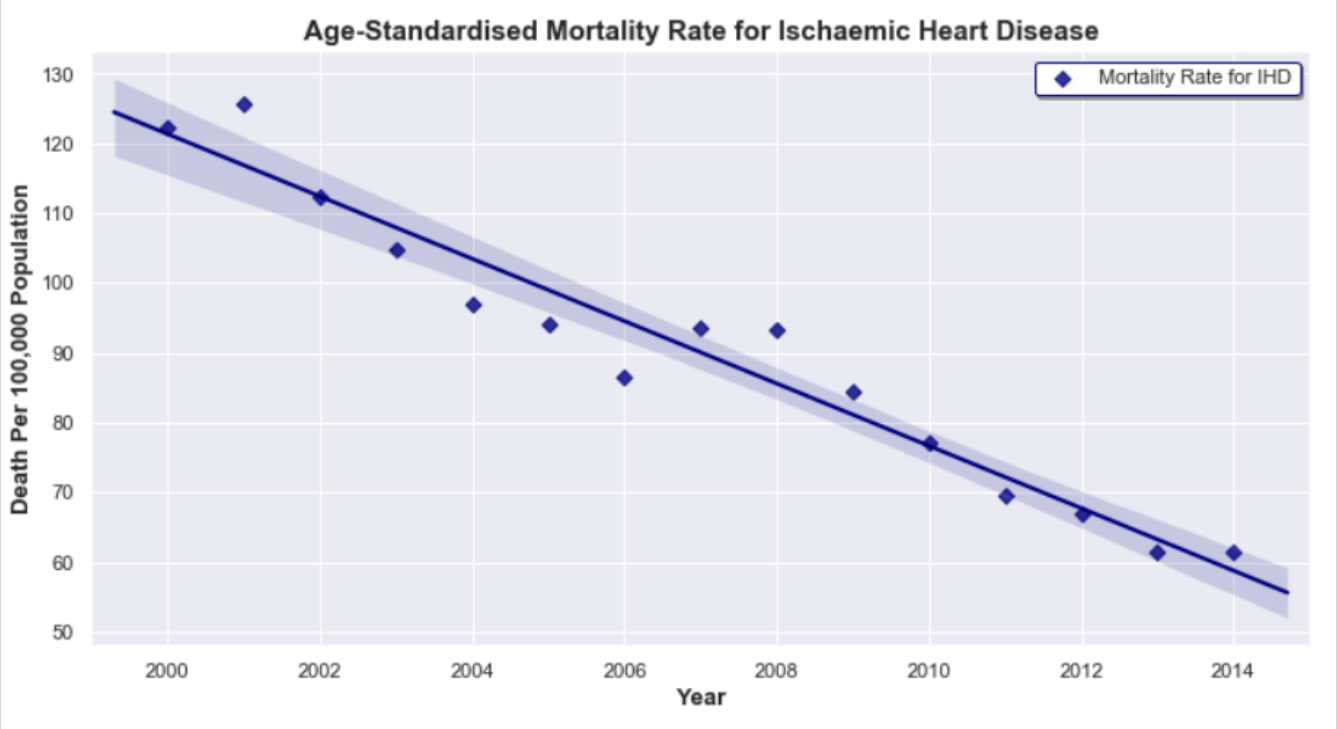
- We shall now analyze the frequency of death caused by some common chronic diseases, as an indicator if there are better healthcare system in place to reduce the chances of people developing such diseases.

4) Mortality Rates due to Chronic Diseases



- Over the recent years, there are less patients dying from the common chronic diseases per 100,000 population.
- This could either mean that modern medicine is indeed effective in prolonging life, or simply because less people are developing these diseases due to better overall healthcare.
- Next, we will see if it is proven that the rate of occurrence of respective chronic diseases declining over the years.

4) Mortality Rates due to Chronic Diseases



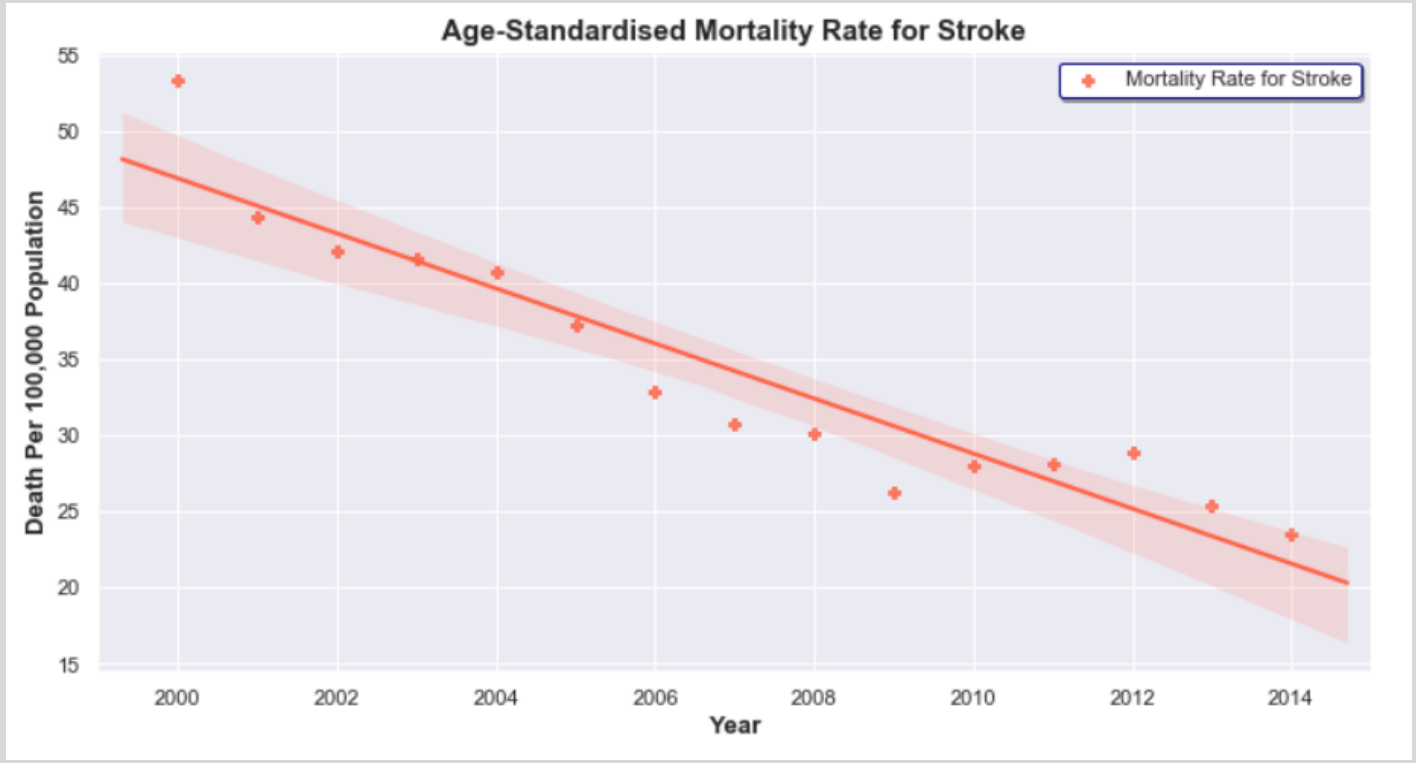
Ischaemic Heart Diseases

Correlation Coefficient:

	year	ihd
year	1.000000	-0.972699
ihd	-0.972699	1.000000

- Based on the chart shown above, it shows a **negative downward trend** which also shows that less people are suffering from Ischaemic Heart Disease (IHD) over the years due to the **advancement of healthcare and medicine over the years.**
- The relationship between two variables can be proven by the correlation coefficient, **r = -0.972699**, which means that there is a **very strong negative linear relationship** between the year and Death Per 100,000 Population.

4) Mortality Rates due to Chronic Diseases



Stroke

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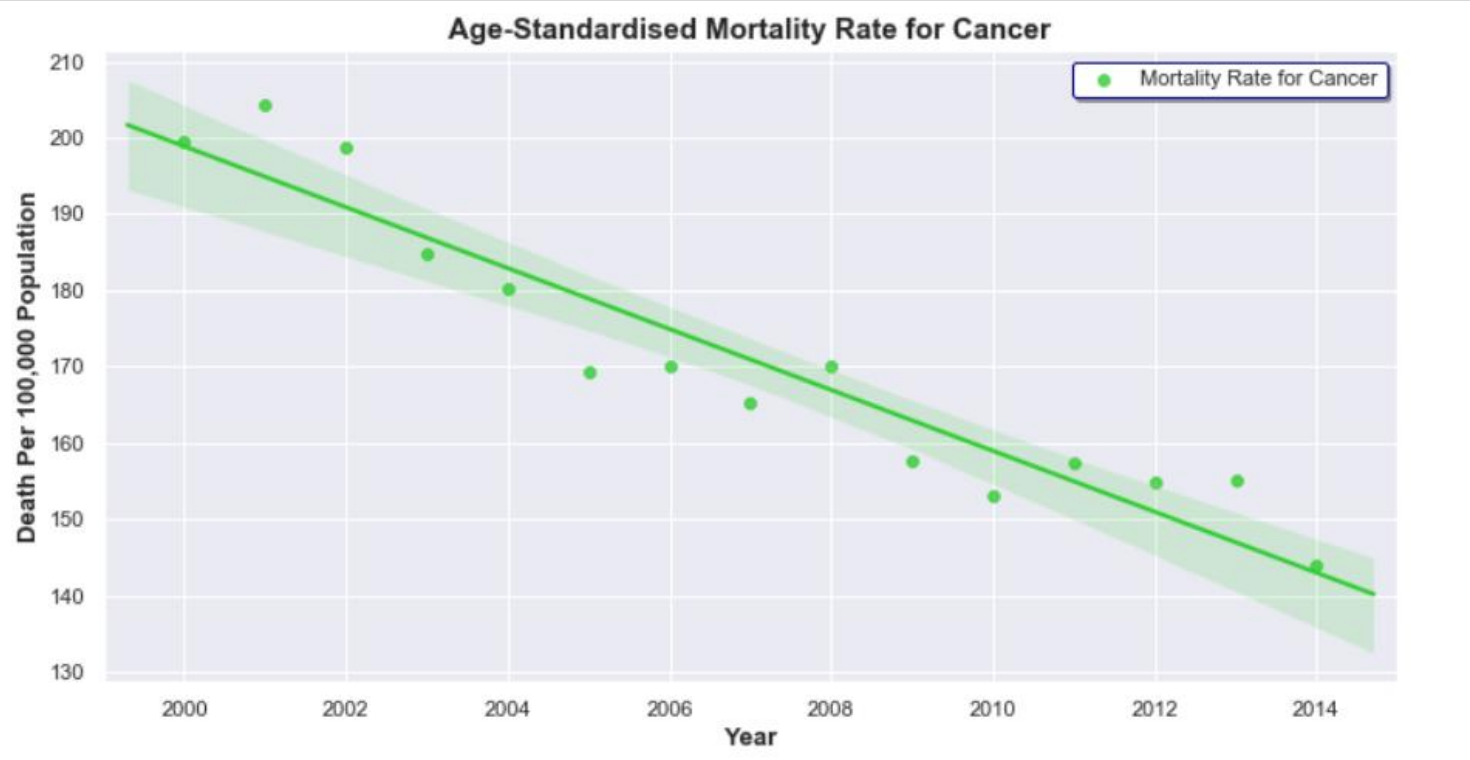
Correlation Coefficient:
             year    stroke
year     1.000000 -0.942922
stroke  -0.942922  1.000000
```

- Based on the chart shown above, it shows a **negative downward trend** which also shows that less people are suffering from Stroke over the years, which probably due to the **advancement in the medicine and healthcare.**
- The relationship between two variables can be proven by the correlation coefficient, **r = -0.942922**, which means that there is a **very strong negative linear relationship** between the year and Death Per 100,000 Population.

4) Mortality Rates due to Chronic Diseases



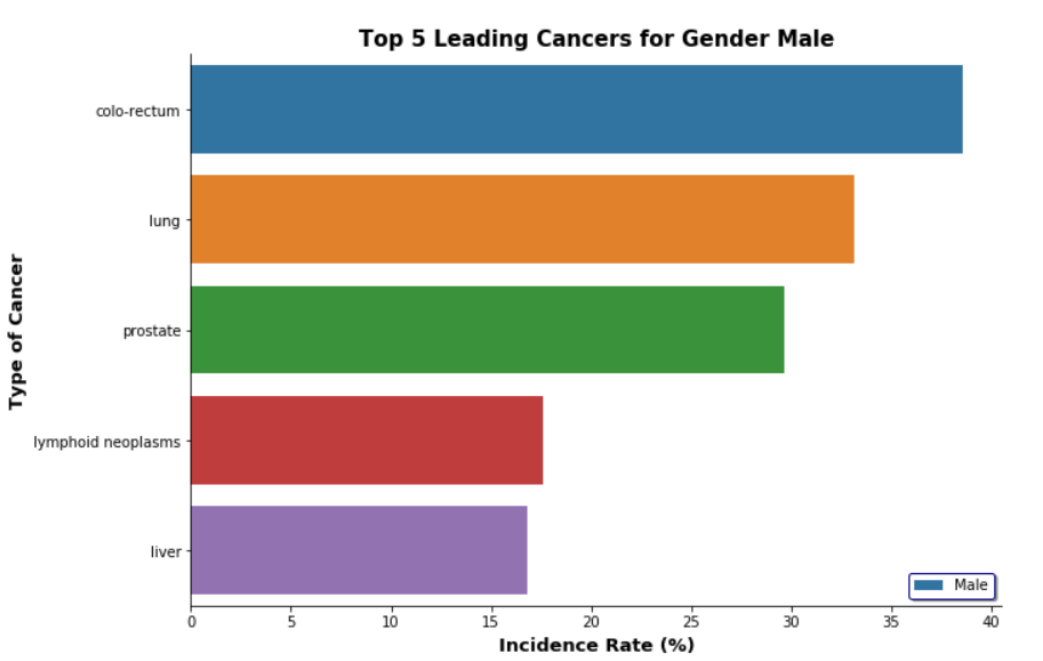
Cancer

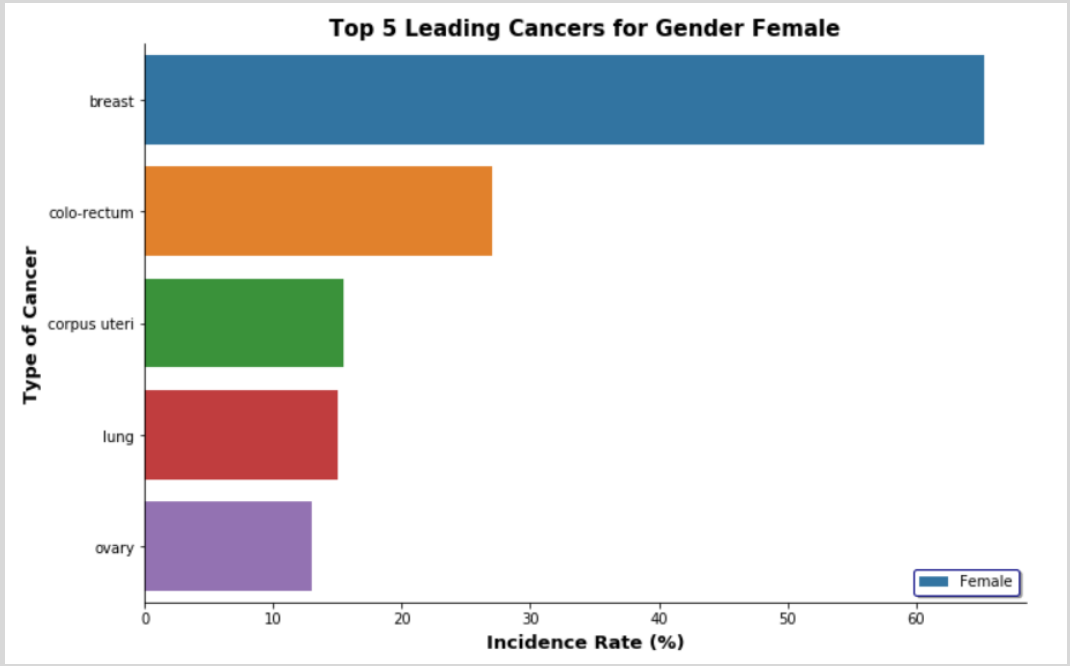
Correlation Coefficient:

	year	cancer
year	1.000000	-0.951277
cancer	-0.951277	1.000000

- Based on the chart shown above, it shows a **negative downward trend** which also shows that less people are suffering from Cancer over the years, which probably due to the **advancement in the medicine and healthcare.**
- The relationship between two variables can be proven by the correlation coefficient, **r = -0951277**, which means that there is a **very strong negative linear relationship** between the year and Death Per 100,000 Population.

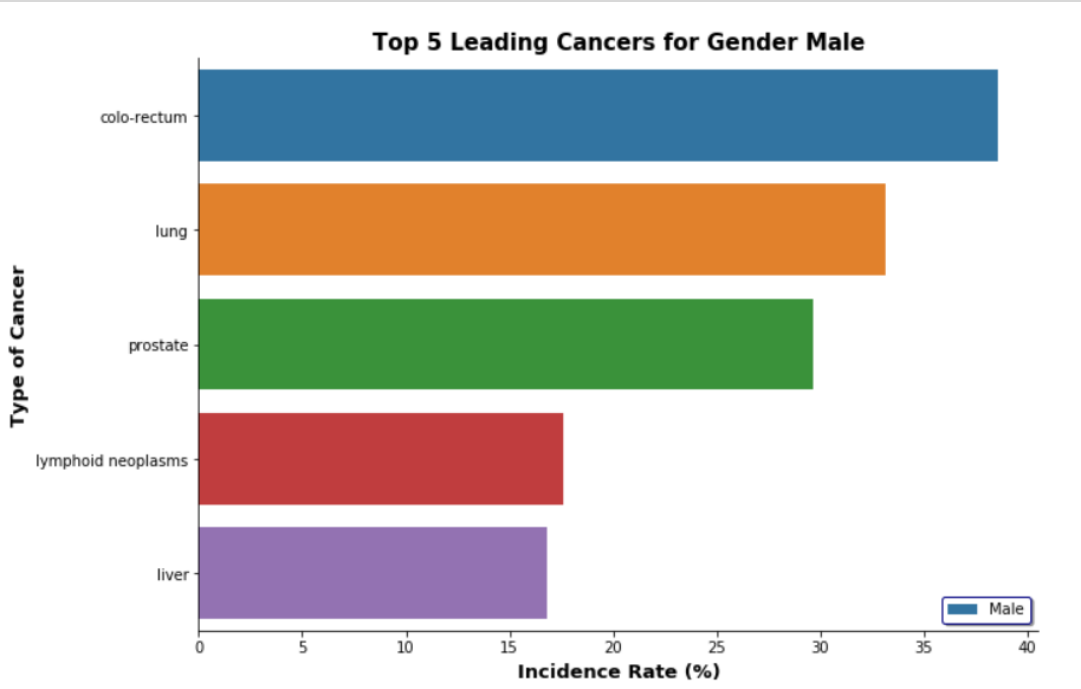
5) Top 5 Leading Cancers by Genders

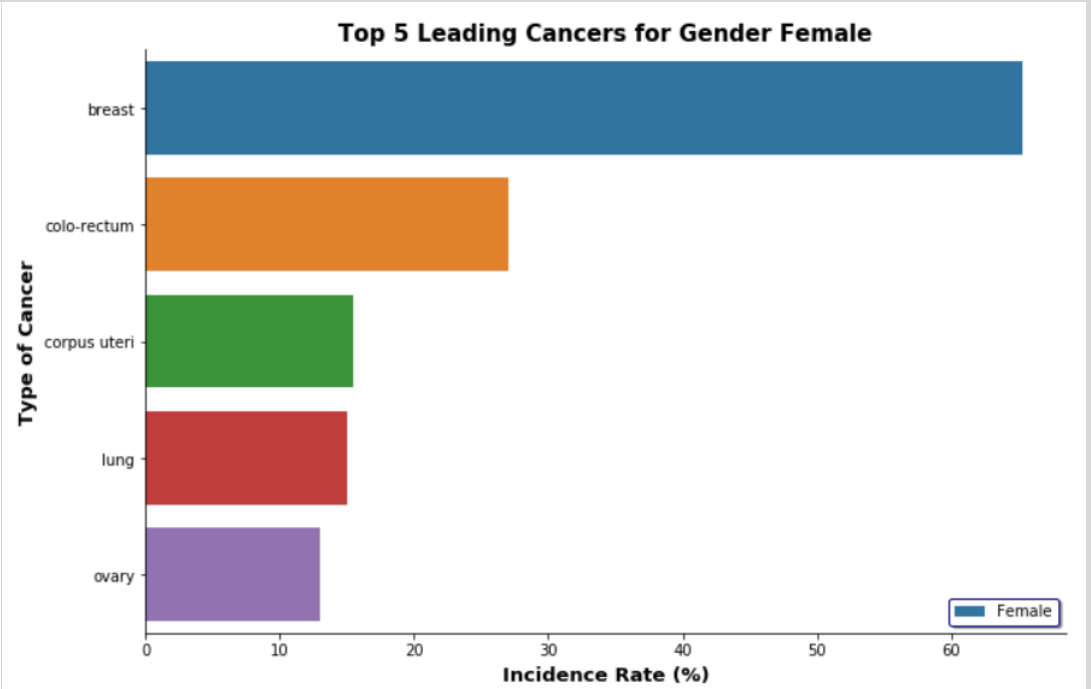




- In this study, we shall further analyze the trend of the **top 5 deadliest cancer** in Singapore by genders.
- In this dataset, it provides the incidence rate of the top 5 cancers by gender in year 2015.

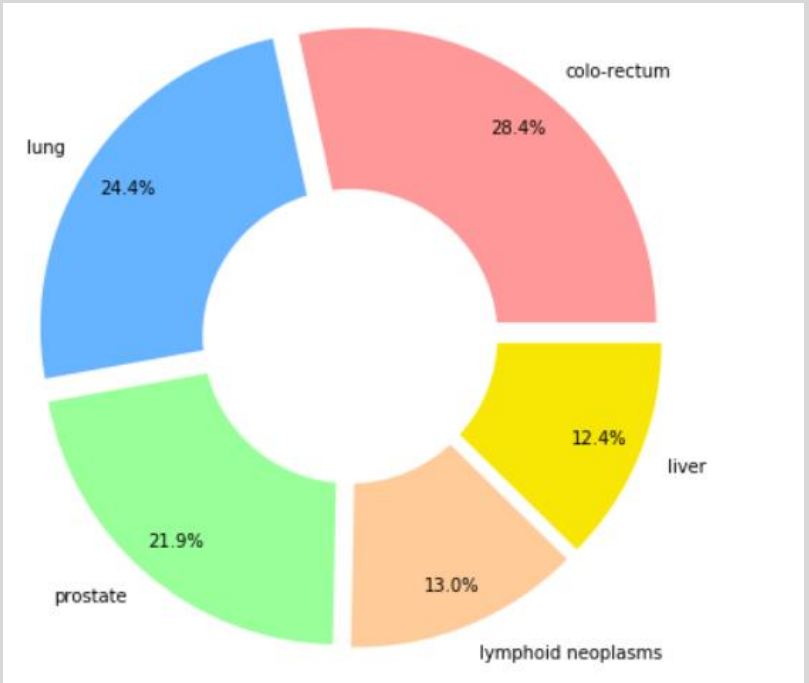
5) Top 5 Leading Cancers by Genders





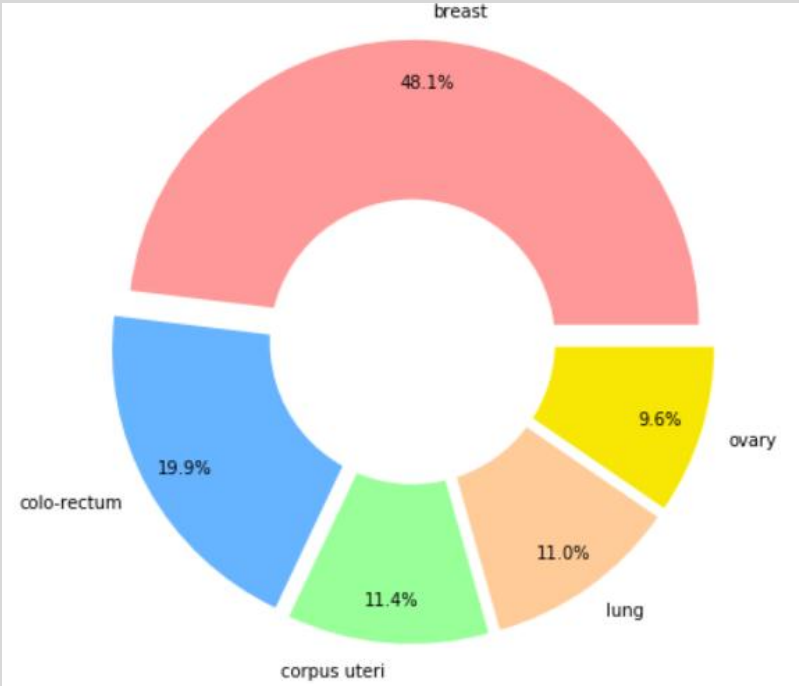
- From the chart above, colorectal, lung, and prostate were the top ranked cancers among the male resident population. The majority of cancer cases are sporadic, i.e. the disease is not inherited.
- By pure chance, many cases of “common” cancers such as colon and lung cancers can appear to run in a family.
- Personal risk depends on factors such as your age, family history of cancer and your tendency to inherit cancer genes. These are beyond your cancer.

5) Top 5 Leading Cancers by Genders



Data of the Top 5 Leading Cancers for Male:

	gender	type_of_cancer	incidence_rate	ranks
0	male	colo-rectum	38.6	1
1	male	lung	33.2	2
2	male	prostate	29.7	3
3	male	lymphoid neoplasms	17.6	4
4	male	liver	16.8	5

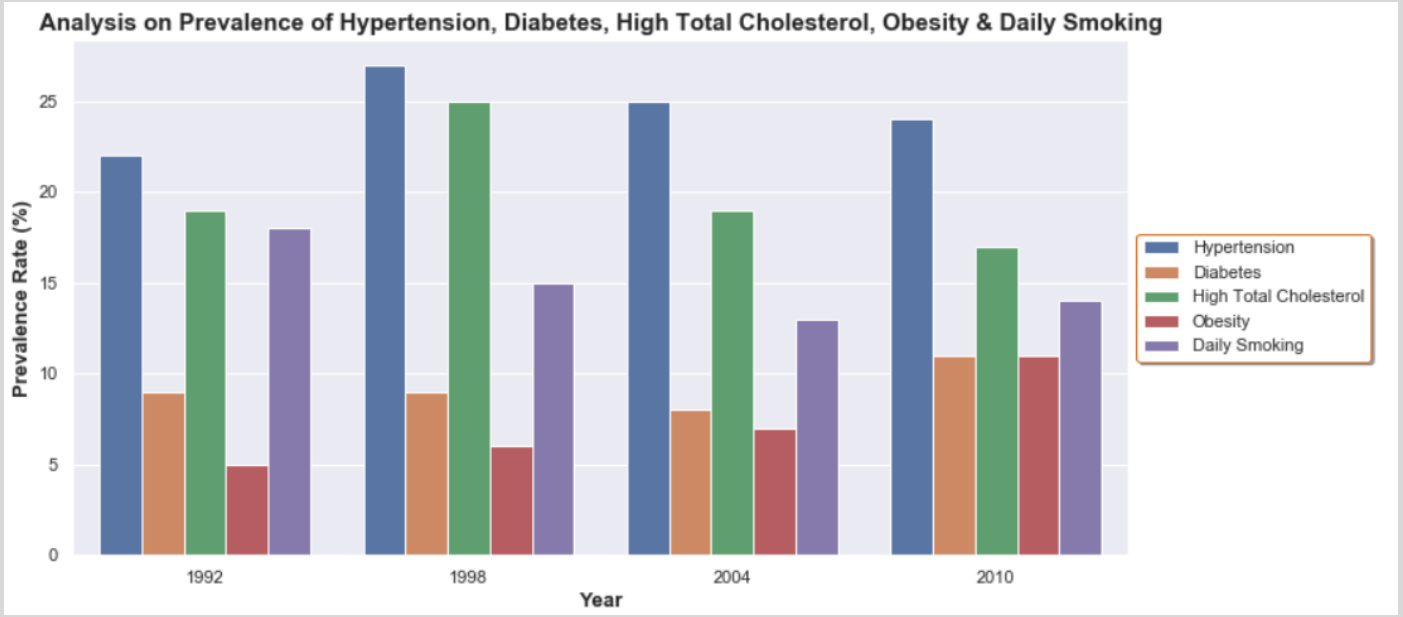


Data of the Top 5 Leading Cancers for Female:

	gender	type_of_cancer	incidence_rate	ranks
0	female	breast	65.3	1
1	female	colo-rectum	27.0	2
2	female	corpus uteri	15.5	3
3	female	lung	15.0	4
4	female	ovary	13.0	5

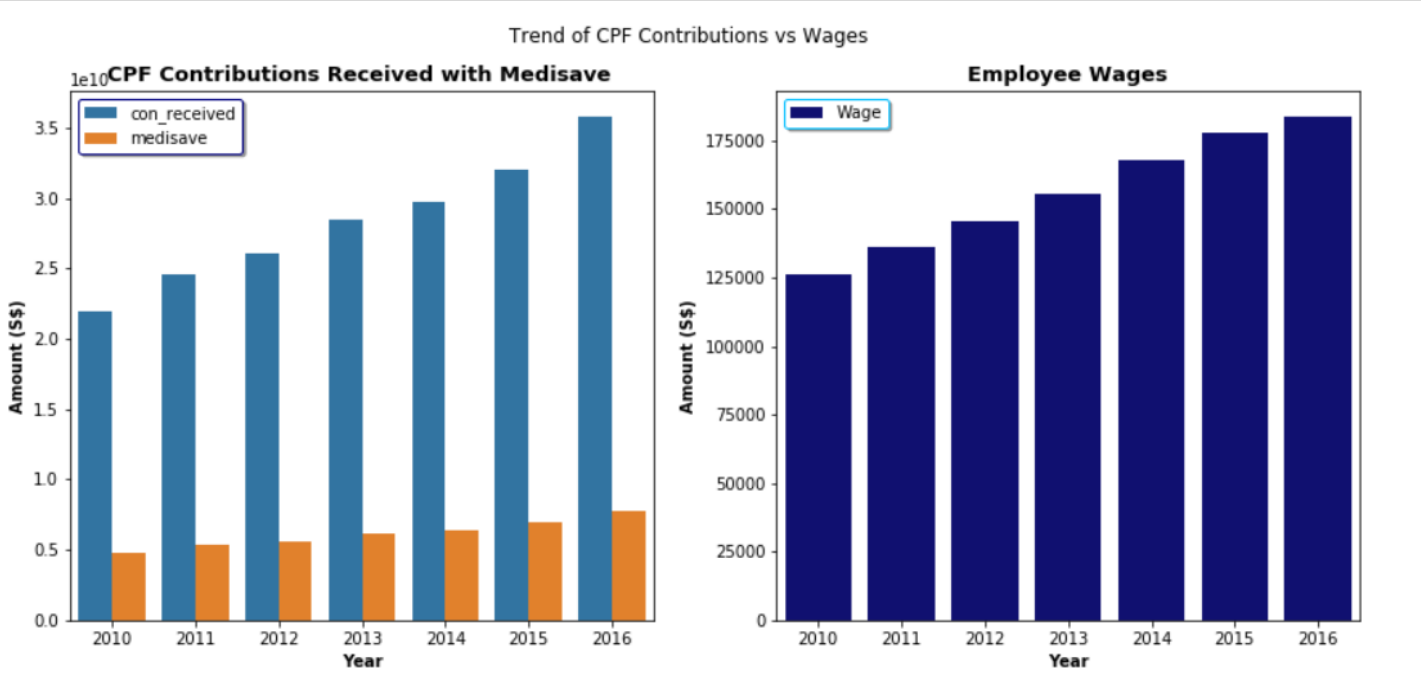
- Other risk factors that are within our control are not genetic. These include our lifestyle, diet, smoking and environmental exposure.
- I believe Singapore healthcare government has been working hard by introducing campaigns activities on improving our healthy lifestyle on regular basis. Aside from government, it is also part of our job as a patient to reduce or prevent these risk factors at minimal level.

6) Prevalence of Hypertension, Diabetes, High Total Cholesterol, Obesity & Daily Smoking



- In general, we can observe a fall in the prevalence of the hypertension, high total cholesterol and daily smoking over the years. However, we can also observe a rise in the prevalence of obesity and diabetes, which is interrelated with each other.
- We can make the following inferences that campaigns and measures to discourage smoking (I quit campaign, tobacco taxes) have been effective in fulling its purpose; future campaigns to encourage healthy lifestyle to bring down diabetes and obesity rates can draw inspiration from the anti-smoking campaigns to try and recreate the success it enjoyed.

7) CPF Contribution with Medisave & Wages



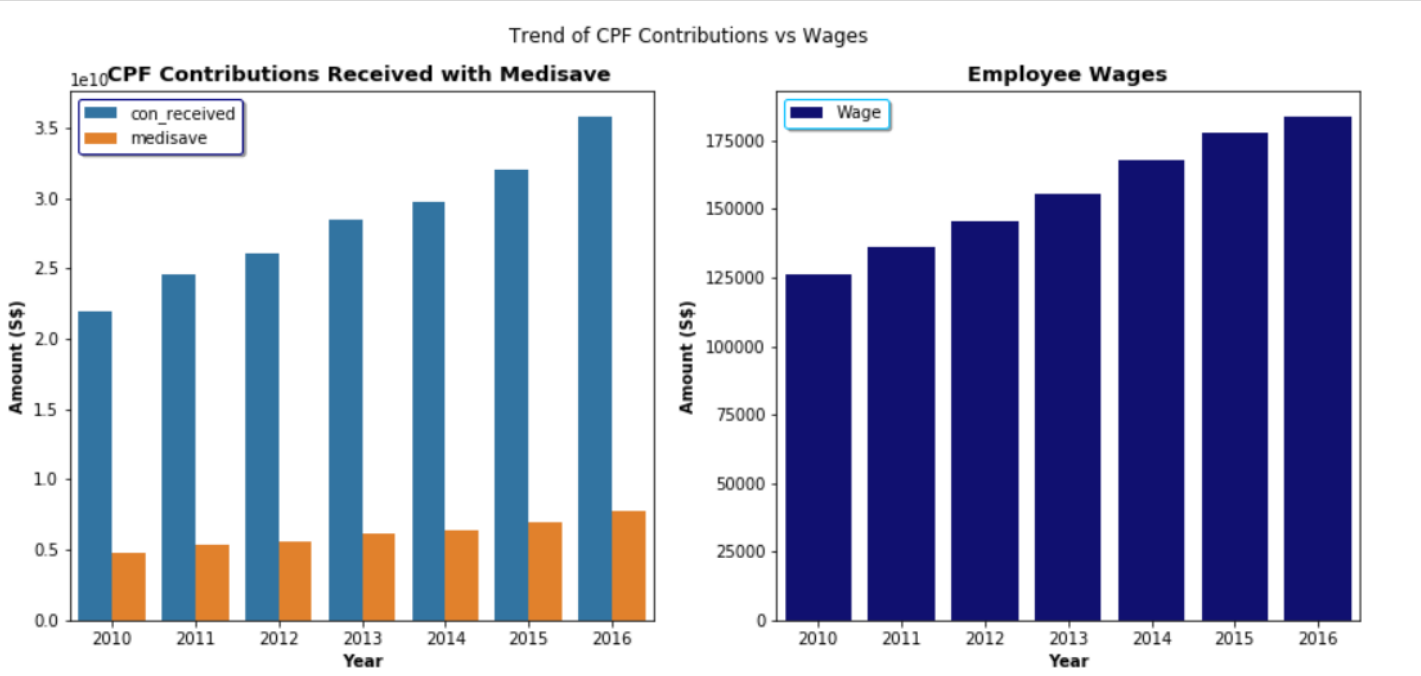
Data for Trends of CPF Contribution and Wages

	yr	con_received	medisave
0	2010	21993000000	4.755243e+09
1	2011	24628000000	5.324973e+09
2	2012	26048000000	5.632000e+09
3	2013	28530000000	6.168649e+09
4	2014	29722000000	6.426378e+09
5	2015	32049000000	6.929514e+09
6	2016	35852000000	7.751784e+09

	year	level_1	value
30	2010	Total	126303.8
31	2011	Total	136246.2
32	2012	Total	145680.0
33	2013	Total	155779.7
34	2014	Total	167539.5
35	2015	Total	177686.9
36	2016	Total	183899.8

- In this study, we will be try to find out how employee wages contribute to their own CPF contributions and further contribute to their own Medisave account.
- As 8% of the wage of the employees is credited to Medisave, so I will be use that toe valuate the amount that is contributed to Medisave CPF Board.
- Noted that the current CPF contribution for both employer and employees combined is 37% of the total wage. The breakdown of the CPF contribution is 21% of the total wage will go to the Ordinary Account OA), 7% of the total wage will go to the Special Account (SA) and the remaining 8% of the total wage will be credited into the Medisave Account.

7) CPF Contribution with Medisave & Wages



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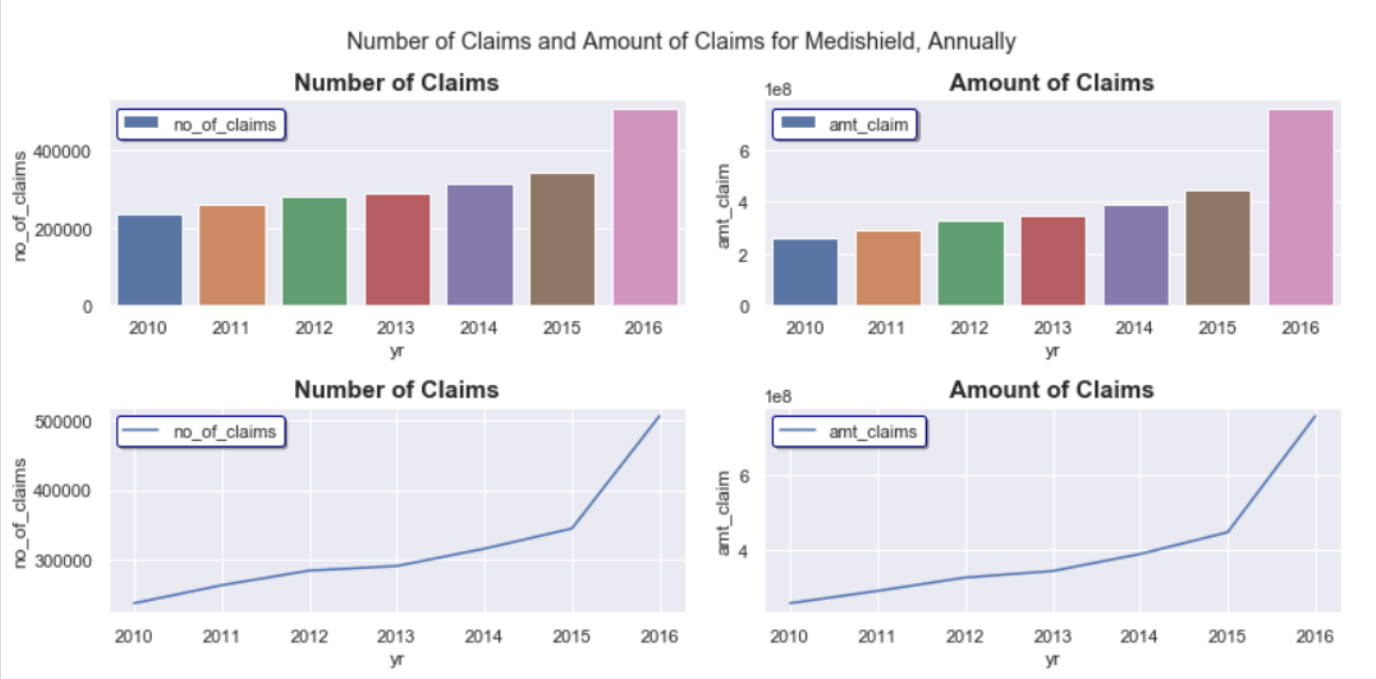
- From the chart above, the increase in wages in Singapore has caused the CPF contribution to increase throughout the years, which ultimately caused an increase in the contribution towards the Medisave.
- As medisave can be used to fund the monthly premiums for Medishield/ Medishield life, most Singaporeans will use their medisave to sustain their Medishield plans as well as to pay their medical fees on chronic diseases such as Diabetes, Hypertension and Cancer.
- In addition, the Singapore government provided various subsidies to lower the cost for the Medishield plans.
- Hence, it can be inferred that most Singaporeans do not need to pay out of their pocket (in cash) to support their medishield plans.

8) Number of Claims and Amount of Claims for Medishield

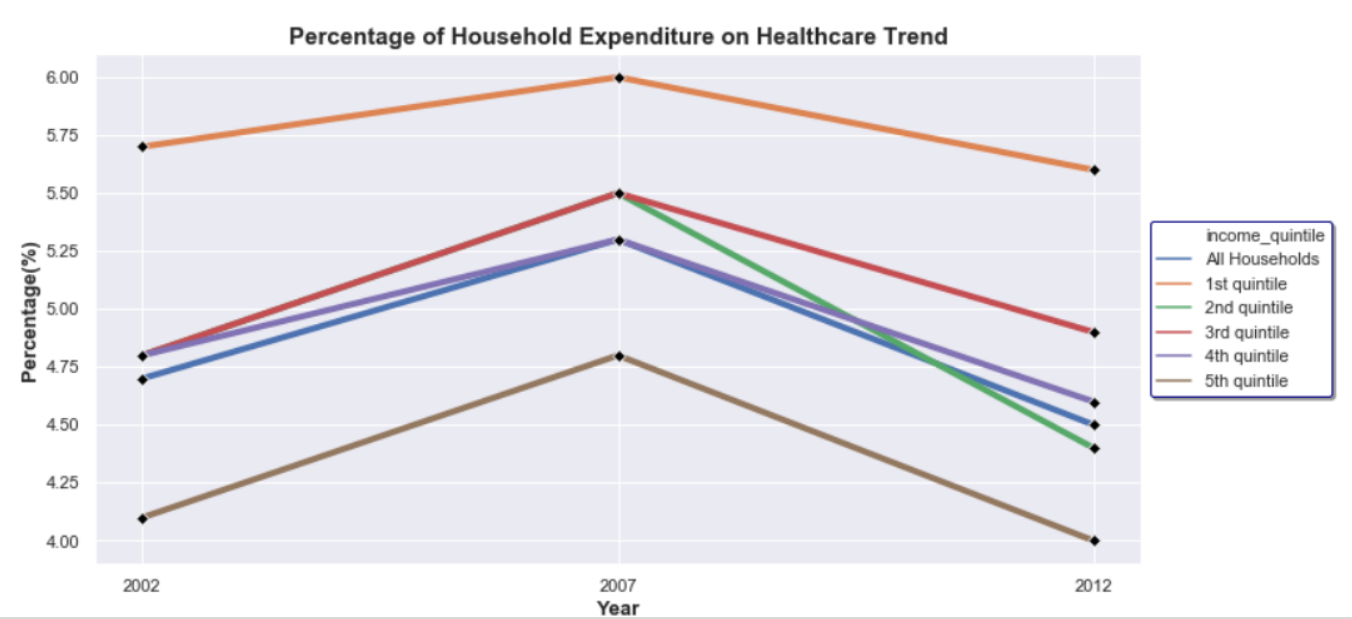


Data for Number of Claims of Medishield and Amount of Claims of Medishield

	yr	no_of_claims	amt_claim
0	2010	235883	258500000
1	2011	262009	291500000
2	2012	283259	327100000
3	2013	289880	344600000
4	2014	314929	389900000
5	2015	344173	448100000
6	2016	507138	758000000

- From the chart above, the number of claims and amount of claims made to medishield plans increase from 2010 to 2016.
- The increase in the number of claims made may be due to the fact that Singapore is facing in an ageing population and there are more people from the baby boomer generation (Born between 1946 and 1964) that requires healthcare and medical services.
- Another explanation could be the government has made it easier for the people to make claims under the medishield plans and this encourages the people to use their medishield benefits to cover their healthcare cost, which makes the overall healthcare more affordable.

9) Household Expenditure on Healthcare



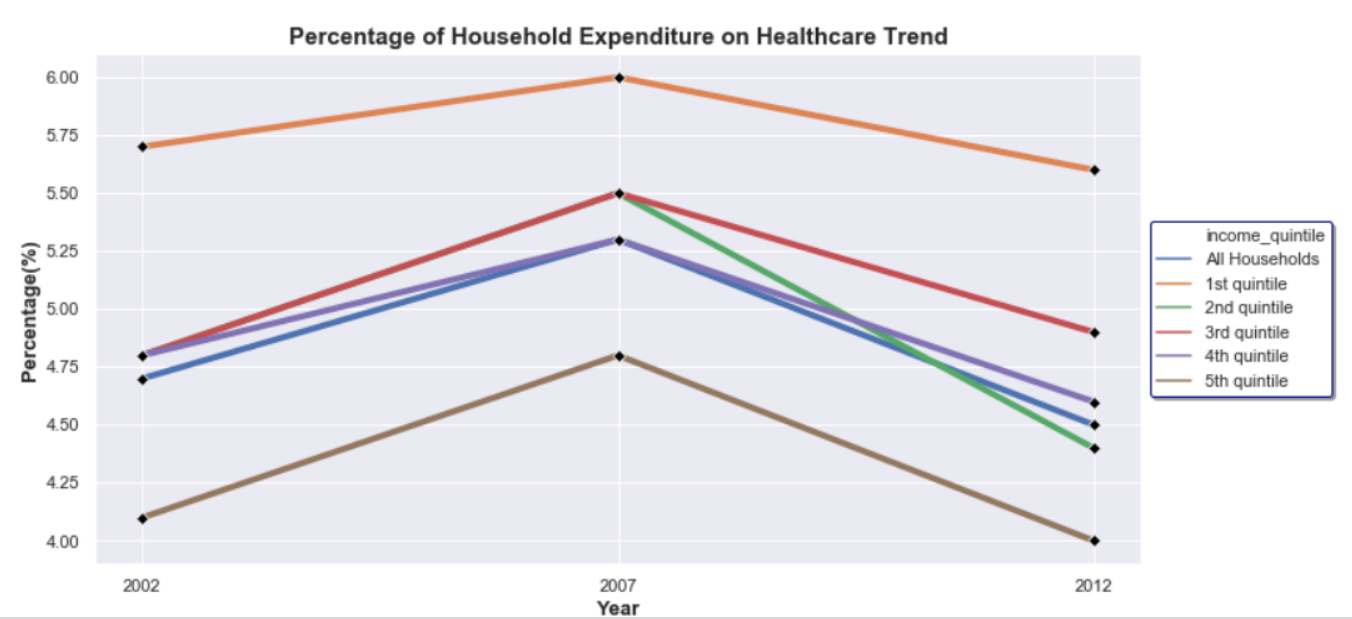
Data for All of the Household Healthcare Expenditure

	period_start	period_end	income_quintile
0	2002	2003	All Households
1	2002	2003	1st quintile
2	2002	2003	2nd quintile
3	2002	2003	3rd quintile
4	2002	2003	4th quintile
5	2002	2003	5th quintile
6	2007	2008	All Households
7	2007	2008	1st quintile
8	2007	2008	2nd quintile
9	2007	2008	3rd quintile
10	2007	2008	4th quintile
11	2007	2008	5th quintile
12	2012	2013	All Households
13	2012	2013	1st quintile
14	2012	2013	2nd quintile
15	2012	2013	3rd quintile
16	2012	2013	4th quintile
17	2012	2013	5th quintile

	percentage_expenditure_on_healthcare
0	4.7
1	5.7
2	4.8
3	4.8
4	4.8
5	4.1
6	5.3
7	6.0
8	5.5
9	5.5
10	5.3
11	4.8
12	4.5
13	5.6
14	4.4
15	4.9
16	4.6
17	4.0

- From the chart above, we can see the different percentages of healthcare expenditure by households of different levels.
- Overall, the household expenditure on healthcare in Singapore has decreased from 2008 to 2012 (blue graph).
- However, upon close inspection, we can see that the households in the 1st quintile have an higher expenditure one healthcare compared to the other quintiles.
- One explanation of this could be that these households are in a lower income level and hence, they have a lower take home after CPF contribution.
- As such, the lower level of income will contribute to a higher percentage of spending in healthcare.

9) Household Expenditure on Healthcare



Data for All of the Household Healthcare Expenditure

	period_start	period_end	income_quintile
0	2002	2003	All Households
1	2002	2003	1st quintile
2	2002	2003	2nd quintile
3	2002	2003	3rd quintile
4	2002	2003	4th quintile
5	2002	2003	5th quintile
6	2007	2008	All Households
7	2007	2008	1st quintile
8	2007	2008	2nd quintile
9	2007	2008	3rd quintile
10	2007	2008	4th quintile
11	2007	2008	5th quintile
12	2012	2013	All Households
13	2012	2013	1st quintile
14	2012	2013	2nd quintile
15	2012	2013	3rd quintile
16	2012	2013	4th quintile
17	2012	2013	5th quintile

	percentage_expenditure_on_healthcare
0	4.7
1	5.7
2	4.8
3	4.8
4	4.8
5	4.1
6	5.3
7	6.0
8	5.5
9	5.5
10	5.3
11	4.8
12	4.5
13	5.6
14	4.4
15	4.9
16	4.6
17	4.0

- On the other hand, the households on the 5th quintile has the smallest expenditure.
- The CPF contributions of these household are capped at the first SGD6000 of the wages (Only the first 6k is subjected to the CPF contribution –e.g. if your salary is SGD6700 per month, only the first SGD6000 contributes to the CPF).
- This will result in a higher take home income in the households of the 5th quintile and it creates a small percentage of the healthcare expenditure (in brown graph)

Limitations

- **Age of the Population**
  - As the premiums of the medishield plan increases with age (the older the person is, the more likely he or she will fall sick, and the insurer will have to bearer more risk).
  - It might increase the healthcare expenditure for the people who do not have enough money in their medisave account as they are required to pay the outstanding balance out of the pocket.
- **Insufficient data points from healthcare dataset**
  - As the data points of the most dataset ends at year 2012, it is very difficult to argument the trends of healthcare in the recent years (From 2013 to 2019). As such, using the trendline that is being shown might not be completely accurate because there will be distortion that could change the way the data looks.
- **Outpatient Treatment**
  - As outpatient treatments at a general practitioner or SingHealth Polyclinic are not taken into consideration in this research, introducing this factor might change the healthcare spending of the household.
- **Preference of Healthcare Providers**
  - This research did not take into account the preference of healthcare of the households. As some household might prefer private healthcare providers compared to government restructured hospitals. This preference will also affect the healthcare spending on the different housheolds.

Conclusion

- From the data analysis shown from Part 1) to 9), we can make the following conclusions about Singapore healthcare system:
  - Singapore's healthcare scene is improving overall as compared to the past, with better cost management from the government, greater emphasis placed on healthcare, and possible better quality of case which translates to less frequent chronic diseases.
  - Nonetheless, there is still room for improvement as Singapore is still behind some countries like Japan in metrics like life expectancy.

Reference Links

Part	Reference Links
1	https://data.gov.sg/dataset/consumer-price-indices-general-and-healthcare
2	https://data.gov.sg/dataset/government-health-expenditure
3	https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=SG
4	https://data.gov.sg/dataset/age-standardised-mortality-rate-for-ischaemic-heart-disease-stroke-and-cancer
5	https://data.gov.sg/dataset/top-5-leading-cancers
6	https://data.gov.sg/dataset/prevalence-of-hypertension-diabetes-high-total-cholesterol-obesity-and-daily-smoking
7	https://data.gov.sg/dataset/cpf-contributions-received-net-amount-withdrawn-annual
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