Final Project Report

Ophthalmic Surgical Data Analytics and Insights

For a Premier Eye Institute and Hospital

in Bangladesh

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#Bar Plot of Cost of Children Cataract Surgery by Hosipital City in Bangladesh

H_City = children_cat.groupby('H_City').H_City.agg(['count'])/children_cat.H_City.count()


plt.bar(H_City.index, H_City.count(), color= 'cornflowerblue')


plt.bar(children_cat.H_City, children.H_City.count()/100, color = 'cornflowerblue')


plt.title('Children Cataract Surgery by Hospital City')

plt.xlabel('Hospital City')

plt.ylabel('%')

plt.show()
```

https://dfrieds.com/data-analysis/bin-values-python-pandas.html

https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.cut.html

https://stackoverflow.com/questions/52277337/is-the-barplot-in-matplotlib-using-the-mean

Executive Summary

In our preliminary research, our group discovered that childhood blindness effects an estimated 40,000 children in Bangladesh. Of those cases, an estimated 36% are treatable and another 32% are preventable (Gilbert & Muhit, 2012). While cataract disease in children is a fairly uncommon phenomenon in the West, cataract disease is responsible for almost all of these occurrences. In the age of modern medicine, it is a tragedy when a disease that is so debilitating goes untreated, especially in children. In this study, our focus was to analyze and gather insights

from the primary dataset provided to us by Ispahani Islamia Eye Institute and Hospital headquartered in Bangladesh. The dataset contains data across three different hospital branches namely Dhaka, Barishal and Jamalpur. It includes important information regarding the patient's medical record number, category of intake, visitation date, surgery duration, and even the cost of the surgery. We proceeded to take the necessary steps for data cleaning by removing null values, duplicates, and outliers. Some new columns were added for further clarification. After visualizing, we discovered that children made up a sizeable number of cataract surgeries. Upon further research, we found that it is a prevalent issue in the Bangladeshi society where children commonly get affected with this condition leading to premature blindness.

We thought it would be both an interesting and important topic for analysis and discussion. We noticed a large percentage of cataract surgery cases affected children and constituted a large cross-section of the demographical data. Therefore, we decided to direct our focus on this specific issue and study the various trends-relationships across the different factors given to us in this dataset. Our objective for this project is to increase awareness amongst the people in Bangladesh in order to facilitate timely care and take preventive measures in order to reduce the negative impacts. We also provided some solutions to the organization and the stakeholders in Bangladesh to better address the challenges related to childhood cataract and seek a wider penetration for s providing a better eye care to those in need.

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Introduction

About Ispahani Islamia Eye Institute and Hospital

Ispahani Islamia Eye Institute & Hospital (IIEI&H) is a distinguished institute in Bangladesh. The great philanthropist M A Ispahani founded the institute in 1960. The 'Not for Profit' Hospital was created with a mandate not only to provide quality eye-care for all segments of society, but to also train doctors, surgeons, and paramedics to serve the country of Bangladesh. Today, the institute has over 1,200 working members with 300 full-time doctors to serve an excess of a million patients annually through its own hospital network.

The team at IIEI&H is committed to the NABH International Gold Quality Accreditation for healthcare and patient safety. In addition, it is moving towards making the hospital paperless, which will not only contribute towards a greener initiative but will also optimize the service timeline for each patient. Currently, the IIEI&H team is working hard to create a 40,000 square feet 'State of Art' operation theater complex in line with global standards. They have also incorporated the first fundamental research facility in Ophthalmology in the country. In addition, IIEI&H has also developed a robust community service approach striving to provide services to as many people as possible taking eye care to the doorstep of the previously unreachable.

Background on the Data Set

This dataset is a record of the Ispahani Islamia Eye Institute and Hospital's surgical data indicating patient demographics, their unique medical record number, category of intake, visitation date as per chronology, surgery duration along with the type and the cost of the respective surgery. Ispahani Islamia Eye Institute and Hospital is the largest and the oldest multi-specialty eye care hospital group in Bangladesh. The Ispahani group operates across Bangladesh and has more than 22 hospitals in various regions. This dataset contains data across three different hospital branches namely Dhaka, Barishal, and Jamalpur.

Brief Description of the Purpose of the Report

The purpose of this report is to scrub the dataset and analyze in order to draw the findings, as per the relationships between the different data elements. This would allow us to understand the

specific trends that are important that would dictate the hospital's approach in managing their operations. Giving the hospital an in-depth understanding on the important findings would enable them to develop a more effective approach to manage their future needs. Below are the questions that we would attempt to effectively answer.

Our questions revolve around our need to understand cataracts in children. We ask from broad questions to more specific ones, like:

1. Why do children get cataracts?
2. Is this a regional phenomenon?
3. What is the demographic of these children?
4. What is the operation of cataracts like in the hospital?

These questions allow us to dive into the health status of Bangladeshi children. Once we understand the background of the situation, we can work with medical professionals and non-profits to recommend a long-term plan addressing this phenomenon.

In order to report and analyze the findings from our questions, we followed the following four distinctive procedures:

- Data Ingestion and Cleaning

  This is the preliminary step where we upload the raw dataset and ensure that we have clean usable so that we can have a more refined findings in the later stages.

- Data Preparation

  This is the second step in this project where we look for inconsistencies in the naming convention and rename the necessary variables and column names for easier referencing. We also created new columns that provide relevant information to proceed with our visualization and analyze the relational data.

- Data Visualization

  It is the third section, wherein we translate our data into visual and graphical representations. Here we can clearly study the datapoints and conduct the trend analysis which facilitates a better understanding of the relations by effective slicing.

- Data Aggregation

It is the final part of our process that is utilized to conduct data descriptive in order to find the patterns by grouping and find the relationship between the dependent and the various independent variables.

A) **Main Content and Analysis (60 points)**:

Process of Collecting the Primary Data

The dataset used for this study is a primary dataset retrieved from the IIEI&H servers containing 9981 rows and 16 columns of data across three different branches and hospital locations. We reached out to the Director of Information Technology and requested for the surgical data ranging from the year 2014 to 2020. It has the basic non-identifiable demographic information about the patient along with the financial information. Since these data elements were retrieved on request, it was tedious and a long process to get the final data. Specific SQL Queries were run to retrieve the data from the servers of the IIEI&H. Since the patient names and other identifiable information fall under healthcare regulations, some of the column variables were redacted.

Data Ingestion and Cleaning

In this segment we first converted our excel spreadsheet into a csv file. We then uploaded this csv file into python and imported the necessary packages (pandas, numpy, matplotlib). Next, it was ensured that we accounted for all the null and duplicate data and refined our dataset. We also identified some of our outliers that would skew our results and corrected them. For example: Age >= 0 as age can't be negative and the Visit_Date != 2008 as the dataset should have data only from 2014-2020.

Data Preparation

Since most of the column names were difficult for code referencing, it was changed to easier ones. Some of the data elements in the columns were in all upper case so it was changed to the string format, for example: Patient's Residence, Hospital Branch,

Patient's Occupation and Doctor's Name. Some of the spelling errors were also corrected and new columns were added to the dataset such as Age, Age_Group, Surgery_Duration, Surgery_Time and Surgery_Cost_USD

Findings from Data Analytics

- ***Data Visualization***

For our approach in Data Visualization we utilized Matplotlib package for the visuals:

Plot 1: This plot shows the percentage of cataract surgery patients in each age category. The composition of this plot includes Children ages 0 to 18 at 14.4%, adults ages 19 to 59 at 65.6%, and seniors ages 60 or older at 20%.

Plot 2: This plot shows the percentages for the five most common surgery types in the Children age category. It shows that of the top five most common sugeries SICS and PHACO, which are both types of cataract surgeries, makeup approximately 79% of surgeries.

Plot 3: This plot shows the percentages for the two types of cataract surgeries for the Children age category. Of the two different types SICS is the more common surgery type at approximately 62.9%, PHACO makes up the other 37.9%.

Plot 4: This plot shows that of the cataract surgeries in the Children age category, approximately 51.5% of surgeries were performed on female patients and 48.5% were performed on male patients. This suggests that cataract disease might be slightly more common in females.

Plot 5: This plot shows the percentages for the five most common Patient Residence cities in the Children age category. It shows that of the top five most common cities approximately 52.1% live in Dhaka, 32.4% live in Barisal, 6.5% live in Kishorganj, 5.2% live in Noakhali, and 3.9% live in Shariat Pur.

Plot 6: This plot shows the average cataract surgery cost by hospital city for the Children age category. Jamalpur is the most expensive on average at 410.86 USD, Barishal is next at 281.65 USD, and Dhaka is the least expensive at 195 USD.

Plot 7: This plot shows the percent of cataract surgeries were performed on the children age category, at each hospital city. Of these surgeries approximately 36.8% were done in Barishal, 36.8% were done in Jamalpur, and 26.5% were done in Dhaka.

Plot 8: This plot shows average cataract surgery cost by age category per year. It appears the cost hit a high in 2015, and has trended downward since that year.

Plot 9: This plot shows average cataract surgery cost for children by sex per year. It appears that each year surgery costs vary greatly for both males and females, and they do not align with one another.

- ***Data Aggregation***

In our Data Aggregation we tried utilizing the numerical data columns along with various categorical data to insinuate relationships with the data, and derive the statistical findings.

a) Descriptive Statistics:

Here we performed the descriptive statistics on the variables of Age, Surgery Cost and the Number of Visits. Through this the most eye-catching numbers turned out to be with respect to the surgery cost. The surgery costs range all the way from $88.2 (least) to $529.4 (max) and as $289.5 as the mean. These numbers are relatively quite low to what we are used to see in America where the mean cost of cataract surgery is $2,691.98 (Camejo, Rupani and Rebenitsch, 2014). The spread for the age of the patients ranges all the way from less than a year old to a 100 year old and with the mean age 40 years. This indicates the spectrum of the complexities of cases handled by the doctors. We also found that the mean number of visits is a little north of 1(1.2). Thus, it is safe to say that on an average the number of visit is approximately 1.

b) Data Grouping to See the Cost Affecting Factors:

Next in order to find what factor invariably affects the cost of the surgery we group the various columns with the surgery cost.

We notice that by compilation of the cost as per the Age Category the minimum ($111.8) and the maximum ($529.4) amount remain constant for the three different

age categories with the mean being highest for the children ($306.2). Since, we found the children having a high mean value we decided to narrow down our focus on the children category. Hence, keeping the children category constant we compare the cost with the Sex, Surgery Type, Hospital Branch, Hospital Location, Surgery Day Time, Number of Visits and the Year of Visit Date in order to identify the cost affecting factors in children. Listed down are the findings across the different variables with respect to the cost for child surgery.

- Sex: It is found that numerically female children have a higher number of surgeries conducted on females (514) than males (484). We can also see that the females have a higher mean in the cost of surgery than the males, where the average cost for female is $313.6 and the average cost of male is $298.4.
- Surgery Type: Here we take a look at the two most popular surgery types i.e. Phaco (Phacoemulsification) and SICS (Small Incision Cataract Surgery) both of which are for cataract. Phaco is a more modern procedure whereas, SICS is more manual in contrast. Looking at the statistics there were more numbers of SICS than Phaco. The total number of Phaco surgeries are 370 comparison to SICS are 628. It also happens to be that Phaco is the most expensive surgery on the list costing $529.4. Moreover, it has a higher mean cost of $399.3 compare to SICS which is at $251.4.
- Hospital Branch: Observing the findings from top three branches conducting surgeries on children, we noticed that the greatest number of surgeries happened in Jamalpur then followed by Barishal and Dhaka. The number of surgeries is as follows 367,367 and 264 respectively. The most expensive surgeries are conducted in Jamalpur costing $529.4 followed by Barishal at $322.9 and Dhaka at $311.8. And their respective means are $410.9, $281.6 and $195.
- Hospital Location: The outputs in this section are exactly the same as the one in the Hospital Branch. But the only new finding is that now we can map the hospital branches with its corresponding hospital locations. We can now deduce that Satadal, Amlapara corresponds to Jamalpur, Barishal City corresponds to Barishal and Farmgate corresponds to Dhaka.

- Surgery Day Time: This segment displays the surgery day time as per midnight, morning, afternoon and evening. The greatest number of surgeries took place during the morning (664) followed by afternoon (250), midnight (67) and evening (16) with each having the mean values of $309.1, $299.7, $298.8 and $314.1 respectively. Midnight to afternoon has the same minimum and minimum values for cost of surgeries which is $529.4 and $111.8. Whereas, evening has the lowest maximum of $470.6 with a relatively high minimum of $200.
- Number of Visits: Next, we look into the number of visits and the associated cost statistics. Patients with 1 visit accounts for 826 cases, for 2 visits it accounts for 129 cases, for 3 it is 30 cases, for 4 it is 8 cases and for 5 it is 5 cases. For each one of them the maximum, minimum and mean are as follows. For 1 visit it is $529.4, $111.8, $306.5, whereas for 2 visits it is $529.4, $111.8, $308.3, for 3 visits it is $529.4, $111.8, $301.6, $94.1, for 4 visits it is $435.3, $117.6, $261.0, $103.1 and for 5 visits it is $470.6, $117.6, $315.3
- Year of Visit Date: In the year of the visit data output, we found that the maximum, minimum and the mean values for cost of cateract surgeries are listed below as per the listed years. 2014 – (maximum) $411.8, (minimum) $235.3, (mean) $301.3, 2015 - (maximum) 529.4, (minimum) $111.8, (mean) $359.6, 2017 - (maximum) $529.4, (minimum) $111.8, (mean) $353.9, 2019 - (maximum) $258.8, (minimum) $258.8, (mean) $258.8, 2020 - (maximum) $322.9, (minimum) $111.8, (mean) $224.1.

c) Data Grouping to 5 Most Popular Children Cataract Doctors: By way of our outputs, we were able to identified the top 5 doctors who performed the greatest number of the cataract surgeries. The top doctors are Dr. Soheb Ahmed, Dr. Nazrul Islam, Dr. Fazlla Rabby, Dr. Kh.Sarmin Ahamed, Dr. Towhida Begum.

d) Number of Child Cataract Surgeries Performed at Each Hospital Location/Branch: We found that Barishal City in Barishal and Satadal, Amlapara in Jamalpur has and aggregate surgery count of 367 and the Farmgate in Dhaka has a total surgery count of 264.

e) Total Surgical Revenue from Child Cataract Procedures: By slicing our data and the method of aggregation we found that the surgical revenue from serving the

child cataract cases sums up to the total of $30,5631.18. This is accounted from our sample data set over the course of years. That being said, most of the surgeries performed were also provided at free or a subsidized cost as keeping the operational models of the non-profit organization.

A) Interpretations on Findings:

Through our findings in the main content and the analysis we found that the Child Cataract cases in Bangladesh has a huge prevalence. As cataract usually affects the older segment of the population, it invoked curiosity amongst us to study the statistics and identify the reasons for it. Through our research we found that Childhood blindness affects an estimated 40,000 children in Bangladesh.

i) 36% of these estimated cases are treatable (primarily cataracts) and 32% are preventable.
ii) Ophthalmologists are not at access in every governmental district hospitals and pediatric eye care facilities are stationed at very selected tertiary health facilities in the urban centers.

In addition, awareness of eye health, and the capacity of government community health workers in identification of eye problems and appropriate referral, is low (Altaras & Haque, 2018, p. 1).

The primary causes of early blindness in this society are noticed amongst children who encompass intrauterine and acquired infectious diseases, teratogens and developmental and molecular genetics, nutritional factors, the consequences of preterm birth, and tumors. Thus, a multidisciplinary approach is hence to address this challenge (Gilbert & Muhit, 2012). Socio-economic factor along with the governmental healthcare design system is another key factor which hinders and retrains the common population of Bangladesh to seek high quality eye care. In fact, on a closer look we learned that despite of the dire need for proper health care in the country and most of the country falling below the poverty level, the government does not offer any structured health insurance system nor provide a socialized healthcare for its citizens. The main reasons behind this are due to a structuring of the financial system and operational limitations. Another aspect to the cause of early childhood

blindness is the lack of awareness amongst people and differed approach of seeking timely healthcare. Therefore, one way to tackle this is to provide counselling the parents and educate them on the child cataract and its treatment options. Failure in doing so can lead to amblyopia later in life or perhaps lead to complete blindness. Once the education, takes place at home it will facilitate an early diagnosis of cataract and provide room for early treatment.

Once the detection takes place parents can seek the right treatment options for their children. In this case, surgery is the most effective option. Although there are some limitations in seeking surgery as an option such as remote geographic location of the patient, other health complications and the complexity involved in the operating on children. But once the hurdles are overcome, the best method to pursue with a cataract surgery is via Phaco (Phacoemulsification), LASIK (laser in-situ keratomileusis) and SICS (Small Incision Cataract Surgery) by inserting the IOL (Intraocular lens) for rectified vision. Lastly, "Parents should be made aware of the importance of postoperative care and of refraction before and after surgery. Using key informants, not only for detection, but also to encourage and motivate parents to comply with long-term and regular follow-up, has also been very successful in a large-scale program in Bangladesh" (Gogate & Muhit, 2009). Therefore, an increased awareness amongst the masses with respect to the various phases involved in eye care is extremely important. Conclusively, eyecare should be an integral part of the comprehensive health care systems with more wide-spread tertiary eye care centers in association with a sustainable healthcare strategy put in place.

1. **Practical Recommendations (7 points)**: Looking at your analysis, you should be able to come up with some practical recommendations that the managers can take to address the issues. The suggestions should be offered with consideration of the realities of the context and available resources. They should also be clearly derived from the findings of the analysis.

There are about 40,000 blind children in Bangladesh- many due to untreated cataracts. Research papers suggest that 69% of them are blind from avoidable causes. They advise that primary health care and primary eye care need to be strengthened; more tertiary pediatric eye care centers need to be developed, and a public health education strategy put in place. Because restoring sight to the 10k cataract blind children and preventing blindness in the 50 million

children at risk remain a major challenge in Bangladesh, we would like to offer the following plan to the Board of Directors.

Overall focus- Our plan focuses on preventive measures to reduce the number of children admitted to the hospital for cataracts. In the long-run, this will be the most important goal. Our three main actions are to provide check-ups, educate the families in Bangladesh, and partner with relevant non-profits.

1. In step 1, we will shift the focus of our volunteer force to install camps in different cities of the country. The point of the camps is to use it as a tool to educate lower-income families around the areas where our hospitals operate. Since many people don't work on weekends, the volunteers will travel every weekend to these regions and remain there for a month. We will hand out pamphlets notifying our weekend sessions and emphasize on the urgency of the situation.
2. In the first weekend session, we will explain what cataracts are and the phenomenon for children with cataracts in Bangladesh. We will speak to them about the link of cataracts to the Bangladeshi diet and their genetic make-up. We will counsel parents on how to look for the early signs of cataracts and how preventable this disease is.
3. In the second weekend, our volunteers will use the information from dieticians to educate families on the Bangladeshi diet and why that needs to change. Food in Bangladesh are unhealthy and hard to digest. We need to research vendors in the area who sell food with anti-oxidants and recommend families to lower the intake of beef, rice, and heavy meals at the same price level. If they still cannot afford the food, we will give them food pantry options that we have partnered with. They can sponsor meals for families and schools.
4. In the third weekend, we will provide free check-ups for families that attend this session. For children who show signs of cataracts or have cataracts, we can utilize mobile ambulances that other non-profits offer to treat them right in the village. We will offer them resources to our hospital nearby if they cannot make it that day.
5. In the fourth weekend, we will garner the trust of the families enough to ask them to start collecting their family medical record. We need to see the pattern overtime and study the genetic effects of cataracts in the population. Most importantly, if families have knowledge that certain diseases have been occurring in the family and record that in their medical history, it is easier to prevent the disease at birth.

This will be our monthly plan in each city that is in the vicinity of our hospital locations. We hope to reduce blindness in 70% of the cases in Bangladeshi children.

Summary and Conclusions :

In this project, we requested and obtained primary eyecare data from the most premier eye care institute (IIEI&H) in Bangladesh. We conducted various data processes on this dataset including data ingestion and cleaning, data preparation, data visualization, and data

aggregation. Based on preliminary research and the nature of the data, we narrowed down our topic of focus to childhood cataract cases in Bangladesh. It is a fairly uncommon phenomenon in the West, therefore we thought it would be both an interesting and important topic for analysis and discussion. We noticed a large percentage of cataract surgery cases affected children and constituted a large cross-section of the demographical data. To study this phenomenon further we sliced the data so that we could solely look at childhood cataract cases, and then used visualization and aggregation to study the relationships between the different variables and how they relate to childhood cataract cases.

With regards to the short-comings of our work we noticed that we did not have adequate child cataract data for the years 2016 and 2018. If we had more time for our project, we would have reached out to the IT Department of the Institution and requested more data for those years. We would have also liked to request the hospital provide us with a few more continuous variables, as this dataset had a very high proportion of demographic categorical data. However, we faced restrictions with healthcare compliance regulations that made it difficult to get more data, as patient identification information is highly sensitive. An additional short-coming we faced was the fact that this dataset was only a sample size from a much larger dataset. Having the full big data, would have increased the accuracy of our insights and findings. Lastly, we had the challenge of the scrubbing process on the raw data that took place prior to working with the data. While it took more time and effort, it was a great learning opportunity to work with real primary data and face the unique challenges that come with it.

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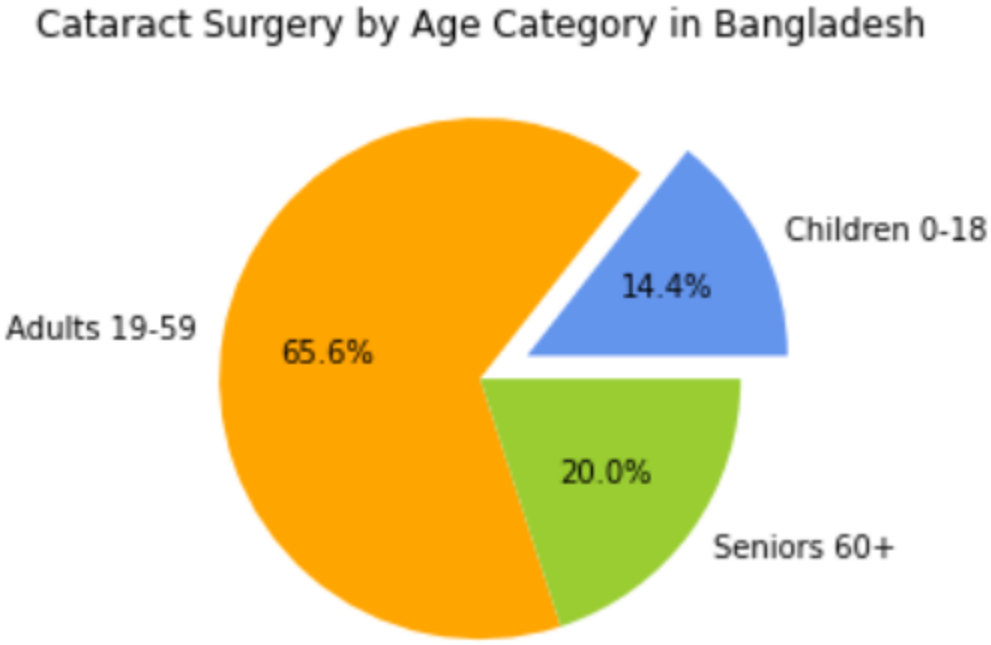
Appendices :


Cataract Surgery by Age Category in Bangladesh
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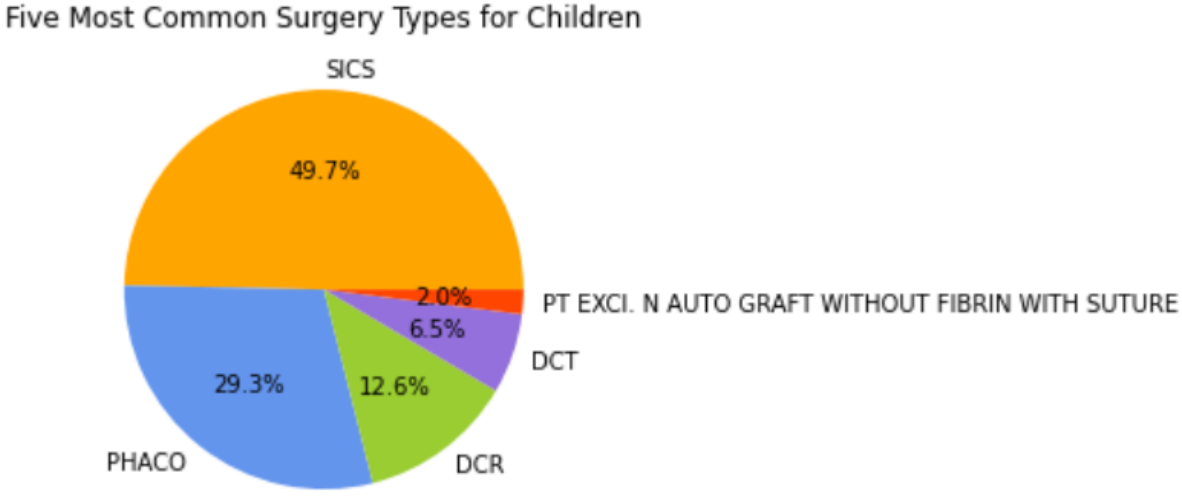
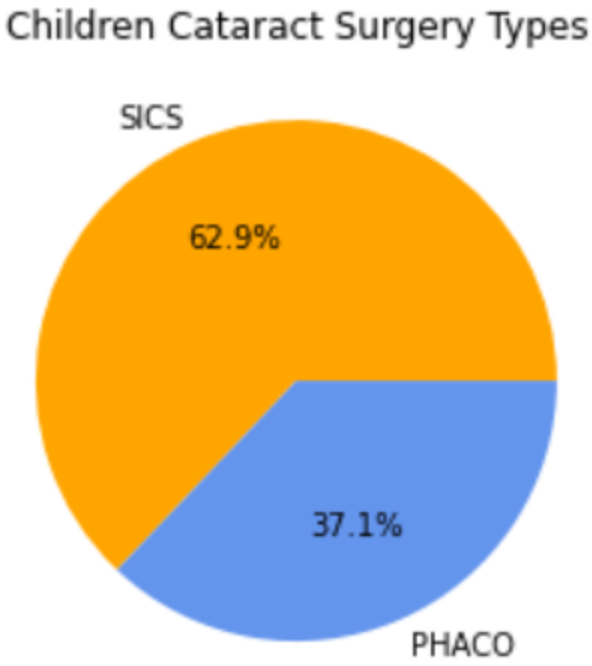
14.4%
Adults 19-59
65.6%
20.0%
Seniors 60+


Five Most Common Surgery Types for Children
SICS
49.7%
2.0%
PT EXCI. N AUTO GRAFT WITHOUT FIBRIN WITH SUTURE
6.5%
DCT
29.3%
12.6%
PHACO
DCR


Children Cataract Surgery Types
SICS
62.9%
37.1%
PHACO