Exploring Pediatric Appendicitis

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Introdution

In 2015, approximately 11.6 million cases of appendicitis were reported, resulting in approximately 50,100 deaths worldwide, deaths could be attributed to many reasons, such as lack of access to medicine, quality of care, and medical diagnostic error.

Helping healthcare professionals make more informed decisions is one way to reduce diagnostic errors.

There are many criteria to do this, such as history taking, physical examination, risk scores (e.g., Alvarado score), and imaging techniques such as ultrasound and CT.

The accuracy of the diagnosis could be improved, for example, by using machine learning. A recent study built a model to predict appendicitis in pediatrics using an interpretable unsupervised machine learning method.

Since a lot of models have been built using just history and physical examinin as predictors, we would use the same dataset to explore the disease for a bit then build models that focus on ultrasonography as a way to diagnose appendicitis.

Methodology

The dataset was acquired in a retrospective study from a cohort of pediatric patients admitted with abdominal pain to Children's Hospital St. Hedwig in Regensburg, Germany.

- Taking a look at the dataset

```
## Rows: 776
## Columns: 5
## $ Sex          <chr> "female", "male", "female", "female", "female", "male", "~
## $ US_Performed <chr> "yes", "yes", "yes", "yes", "yes", "yes", "yes", "yes", "~
## $ Severity     <chr> "uncomplicated", "uncomplicated", "uncomplicated", "uncom~
## $ Management   <chr> "conservative", "conservative", "conservative", "conserva~
## $ Diagnosis    <chr> "appendicitis", "no appendicitis", "no appendicitis", "no~
```

Table 1: First Ten Rows of the Pediatric Patients Dataset

Sex	US_Performed	Severity	Management	Diagnosis
female	yes	uncomplicated	conservative	no appendicitis
female	yes	complicated	primary surgical	appendicitis

Sex	US_Performed	Severity	Management	Diagnosis
male	yes	complicated	primary surgical	appendicitis
male	yes	uncomplicated	conservative	no appendicitis
female	yes	uncomplicated	conservative	appendicitis
male	yes	uncomplicated	conservative	appendicitis
female	yes	uncomplicated	conservative	appendicitis
female	yes	uncomplicated	conservative	appendicitis
male	yes	complicated	primary surgical	appendicitis
male	yes	uncomplicated	conservative	no appendicitis

```
## Number of missing values is 14008
```

Some Plots

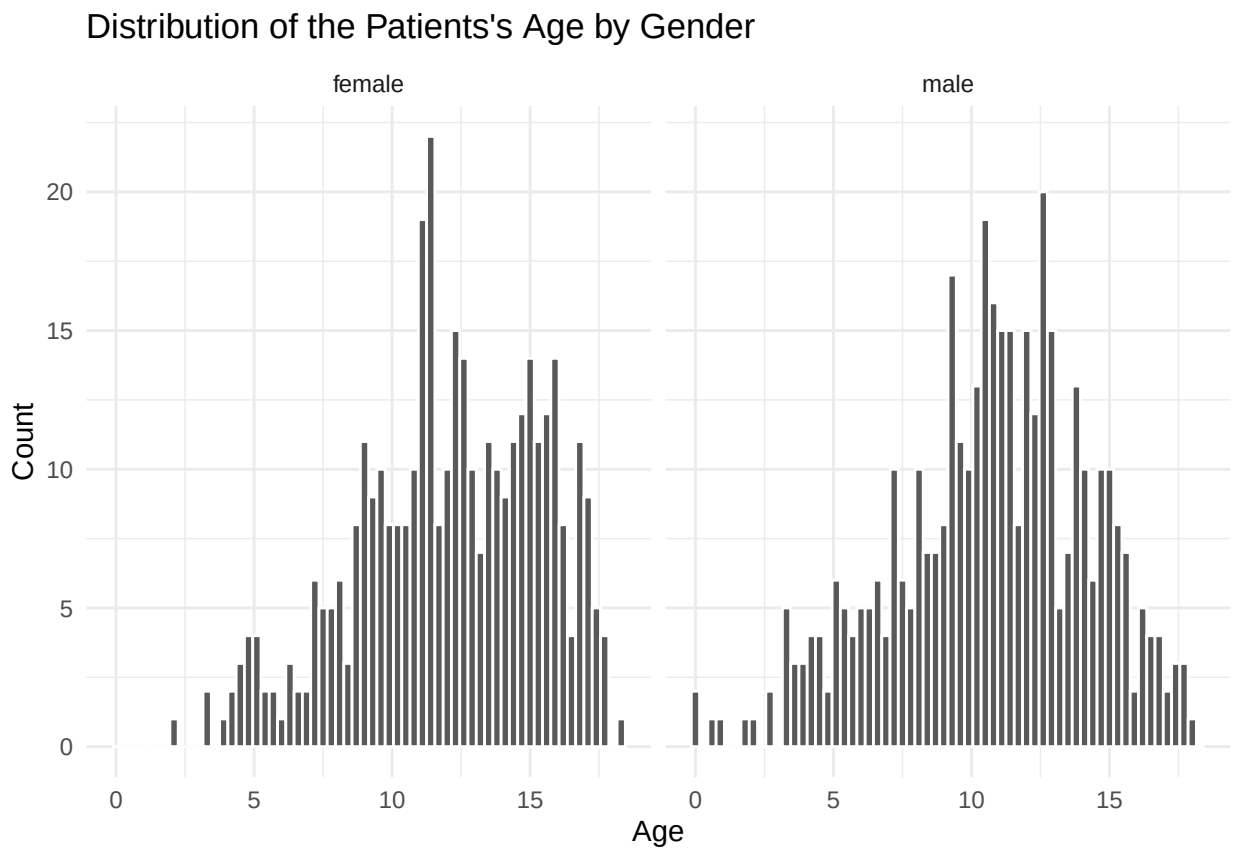


Figure 1: Distribution of the Patients's Age by Gender

Table 2: The Mean Age of Patients By Gender

Sex	Mean
female	12.06
male	10.68

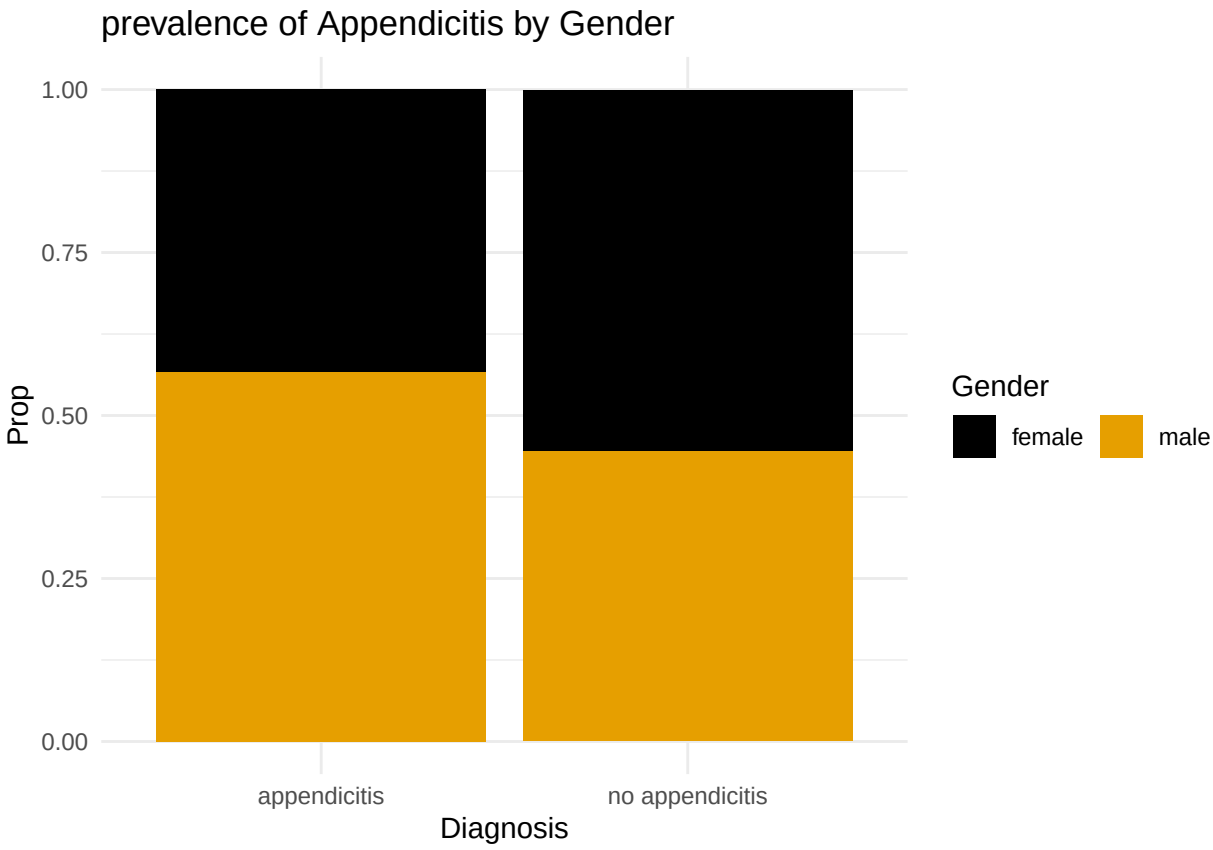


Figure 2: Prevalence of Appendicitis by Gender

Table 3: Prevalence of Appendicitis by Gender

Sex	Diagnosis	n	p
female	appendicitis	200	0.53
female	no appendicitis	176	0.47
male	appendicitis	262	0.65
male	no appendicitis	141	0.35

- Figure 2 shows that the prevalence in appendicitis is more males than females, which is consistent with existing findings, but it is not that substantial.

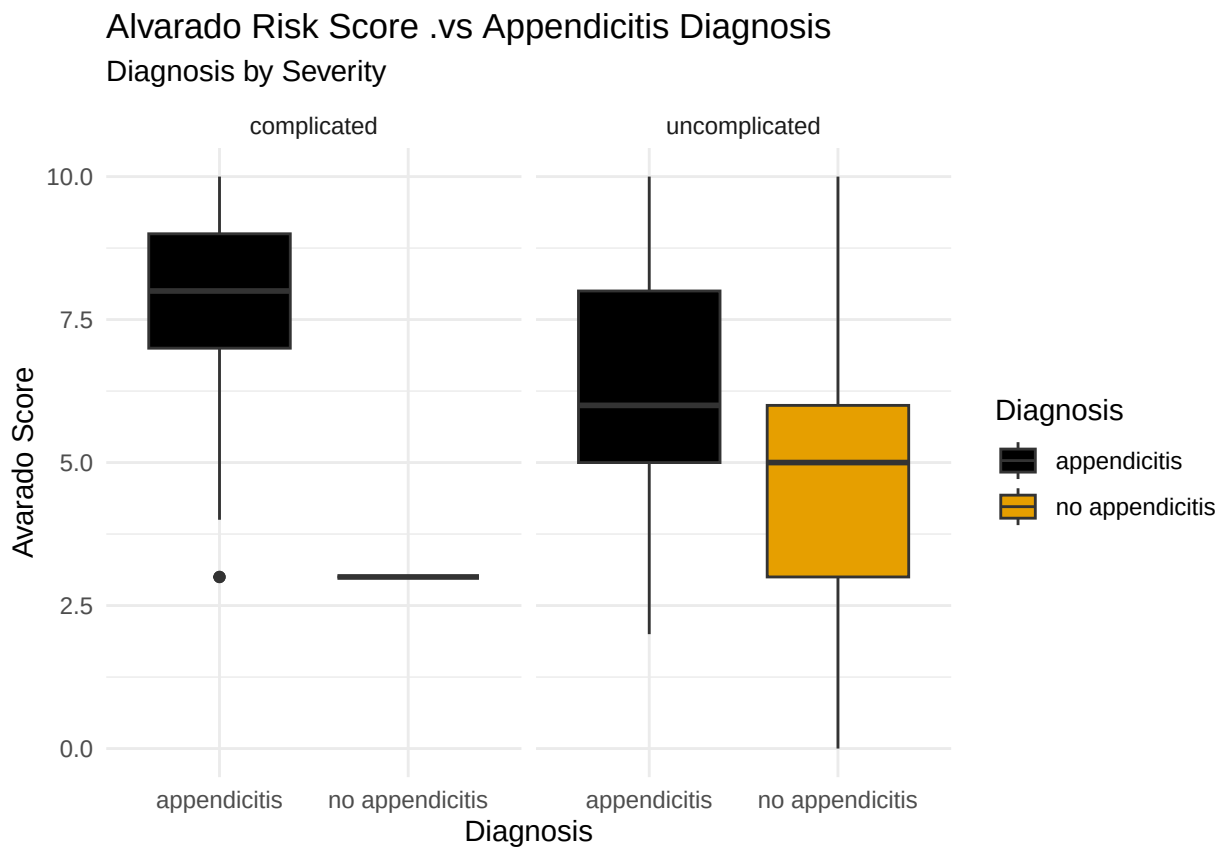


Figure 3: Alvarado Risk Score .vs Appendicitis Diagnosis

Table 4: Alvarado Risk Score .vs Appendicitis Diagnosis

Diagnosis	mean	median
appendicitis	6.67	7
no appendicitis	4.83	5

- Alvarado score is a system that have been developed to identify people who are likely to have appendicitis, as a score below 5 suggests against a diagnosis of appendicitis, while a score of 7 or more is predictive of acute appendicitis, but it is performance varies. Here, the severity of the diagnosis was added to see if the score also differed.

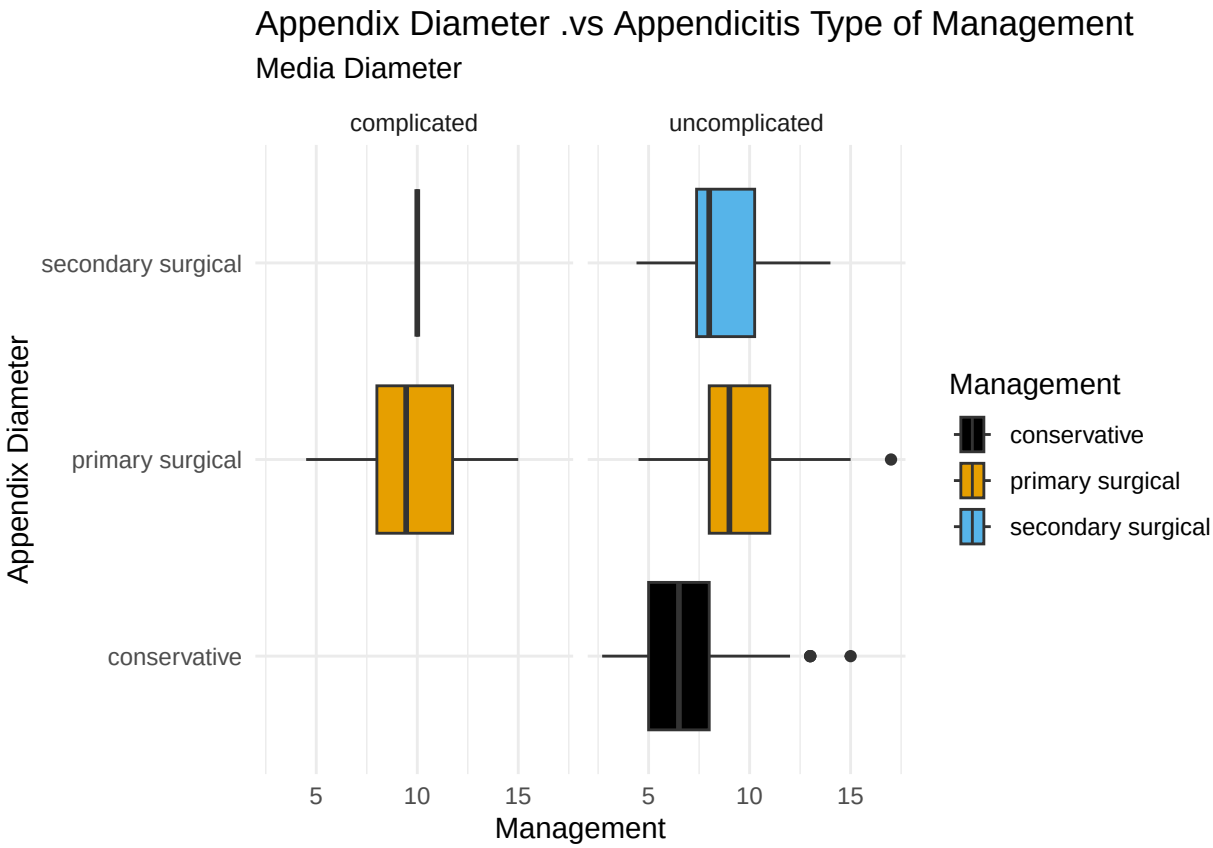


Figure 4: Appendix Diameter .vs Appendicitis Type of Management

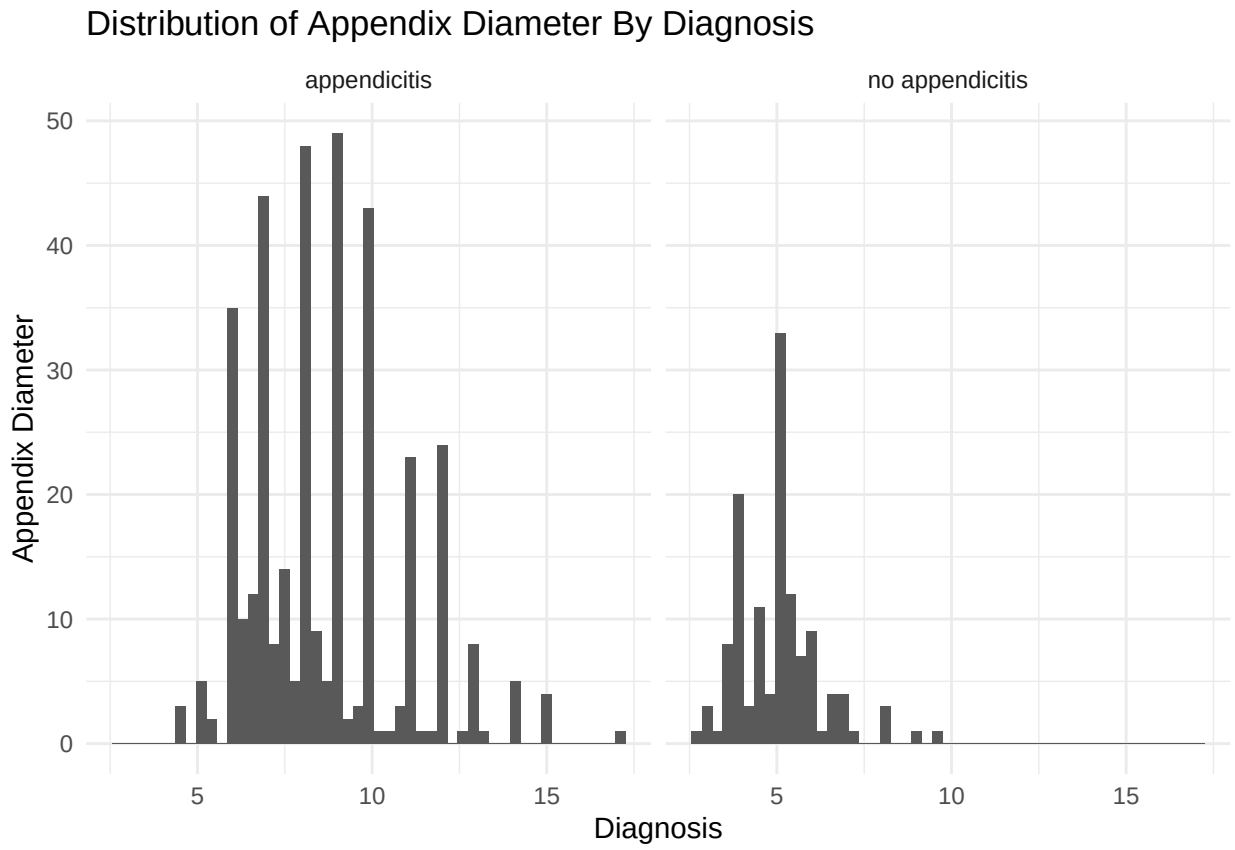
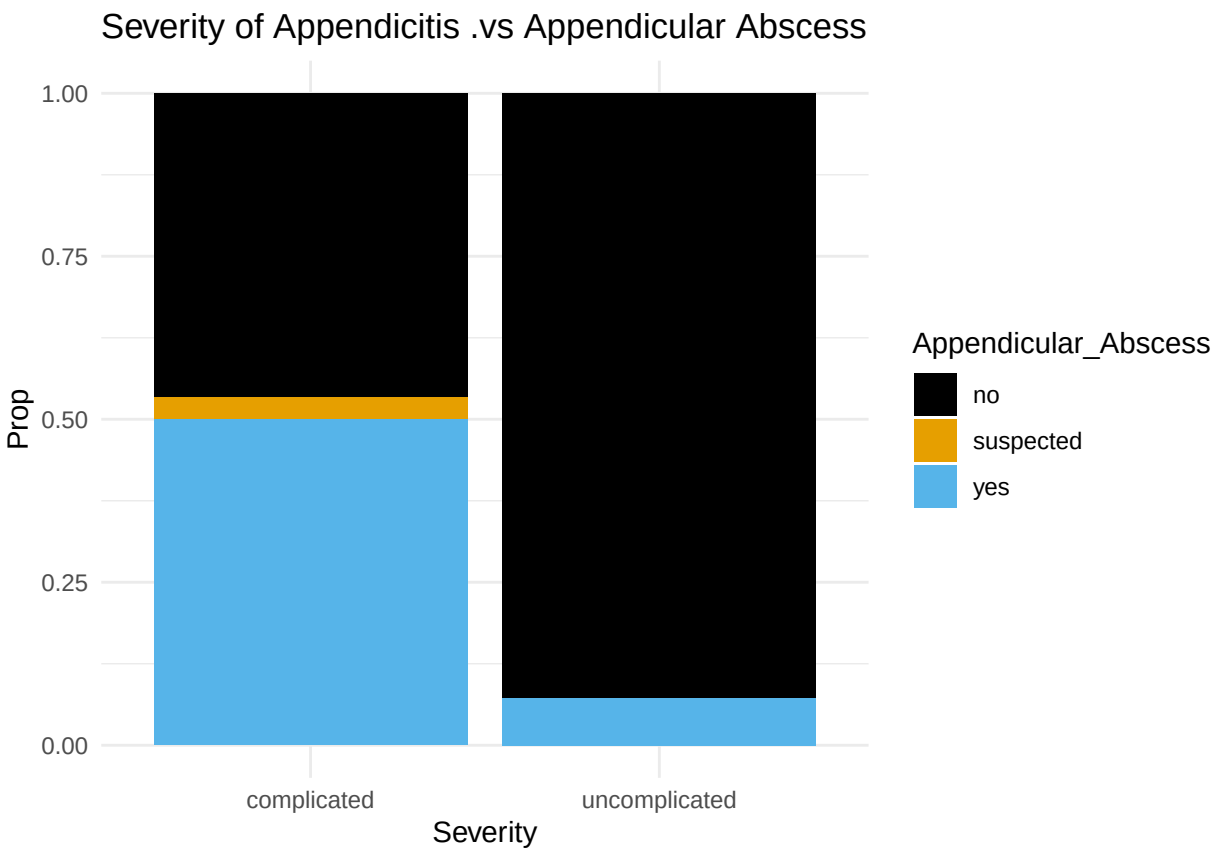


Figure 5: Appendix Diameter .vs Appendicitis Type of Management

Table 5: Mean of Appendix Diameter By Appendicitis Management

Diagnosis	mean	median
appendicitis	8.70	8.2
no appendicitis	5.04	5.0

- 

- In severe cases, abscess can be seen and Figure 4 shows that the proportion is higher for complicated cases.

Statistical Analysis

Hypothesis testing

- Since the use of ultrasound is less expensive and less harmful than CT, it streamlines the diagnostic process.

Here we will test if the addition of **appendiceal diameter** will have a discernible difference on the outcome of the diagnosis, the method we will use is hypothesis testing with **randomization**.

The two populations of interest in this study are pediatric patients who do or do not have appendicitis.

Let p *= the true mean of appendix diameter in pediatric patients.

- So our hypotheses are

$H_0 : p_{Appendicitis} = p_{no\ Appendicitis}$

$H_A : p_{Appendicitis} \neq p_{no\ Appendicitis}$

- With a p-value of 0, which is smaller than the discernability level of 0.05, we reject the null hypothesis. The data provide convincing evidence that there is a difference between the mean appendix diameters of pediatric patients with and without appendicitis.

Table 6: 95% confidence interval for the difference in mean between patients diagnosed with appendicitis or no appendicitis.

lower_ci	upper_ci
3.37	3.94

- *We are 95% confident that the mean diameter of the appendix in pediatric patients with "appendicitis" is 3.37 to 3.94 greater than in pediatric patients without appendicitis..*

Modeling

- To help the health workers make more informed decisions (i.e, Accurately diagnosing the appendicitis) we would use machine learning.

We will build Supervised explainable models like logistic regression then test and validate the model.

So we will use **cross validation** as way to build the model then we would use **ROC** to check the models precision and accuracy.

Table 7: A Model to Diagnose Appendicitis With Avarado Score

pred_class	pred_appendicitis	pred_no_appendicitis	alvarado_score
appendicitis	0.78	0.22	6
appendicitis	0.95	0.05	9
appendicitis	0.68	0.32	5
appendicitis	0.86	0.14	7
appendicitis	0.56	0.44	4
appendicitis	0.56	0.44	4
appendicitis	0.78	0.22	6
no appendicitis	0.30	0.70	2
appendicitis	0.86	0.14	7
appendicitis	0.86	0.14	7

Table 8: Precision and Accuracy of Model to Diagnose Appendicitis With Avarado Score

.pred_class	Diagnosis	n	p	decision
appendicitis	appendicitis	67	0.96	True positive
no appendicitis	appendicitis	3	0.04	False negative

.pred_class	Diagnosis	n	p	decision
appendicitis	no appendicitis	14	0.61	False positive
no appendicitis	no appendicitis	9	0.39	True negative

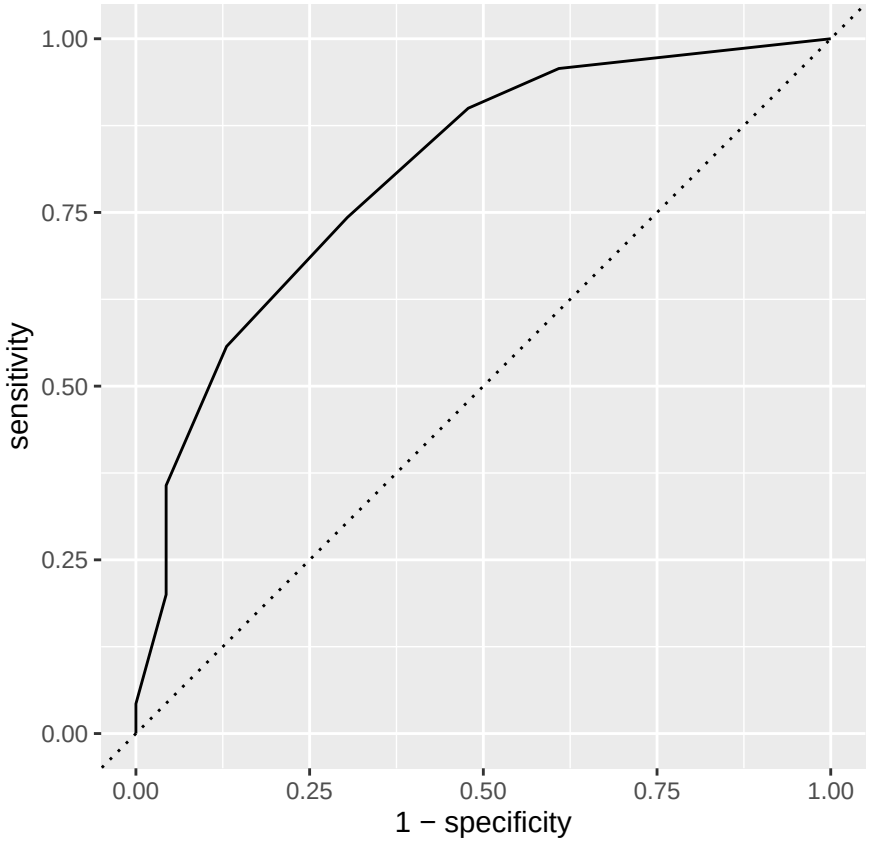
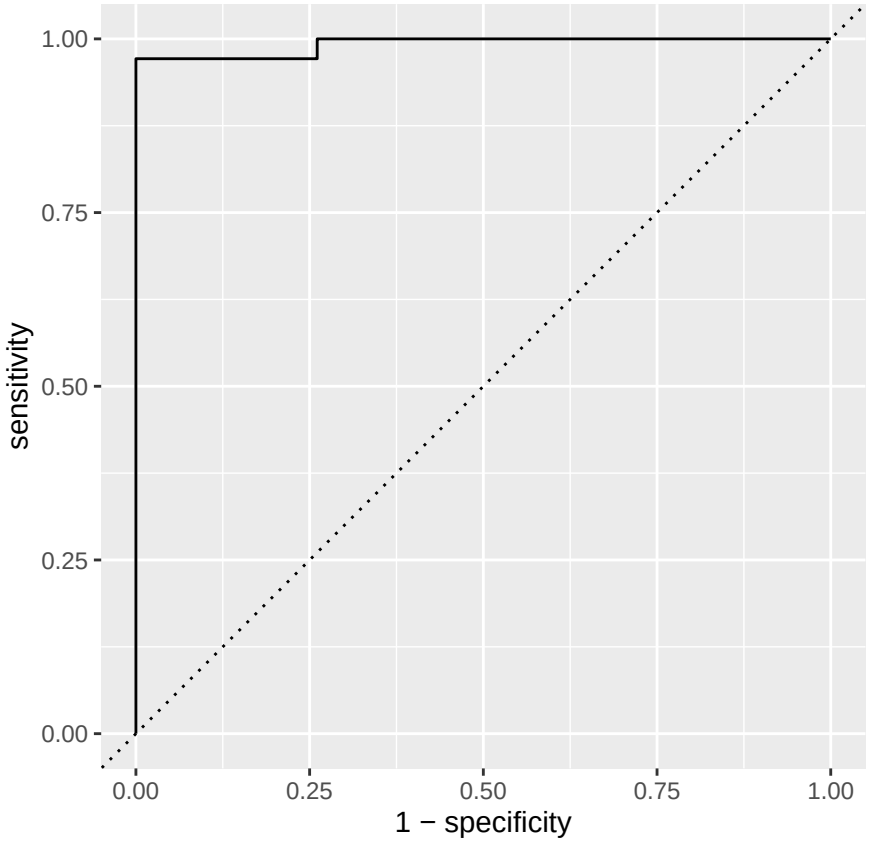


Table 9: A Model to Diagnose Appendicitis With Avarado Score, Appendix_Diameter, Weight and BMI

pred_class	pred_appendicitis	pred_no_appendicitis
no appendicitis	0.01	0.99
no appendicitis	0.10	0.90
no appendicitis	0.29	0.71
appendicitis	0.80	0.20
appendicitis	0.96	0.04
no appendicitis	0.46	0.54
appendicitis	1.00	0.00
no appendicitis	0.03	0.97
appendicitis	0.85	0.15
appendicitis	1.00	0.00

Table 10: Precision and Accuracy of Model to Diagnose Appendicitis With Avarado Score, Appendix_Diameter, Weight and BMI

.pred_class	Diagnosis	n	p	decision
appendicitis	appendicitis	67	0.96	True positive
no appendicitis	appendicitis	3	0.04	False negative
no appendicitis	no appendicitis	23	1.00	True negative



- The second model that used **Ultra-sonography** results showed lower **False positives and negatives**. per table above.

Diagnosing

```
## # A tibble: 1 x 2
##   .pred_appendicitis `.pred_no appendicitis`
##                <dbl>                   <dbl>
## 1               1.00                0.000358
```

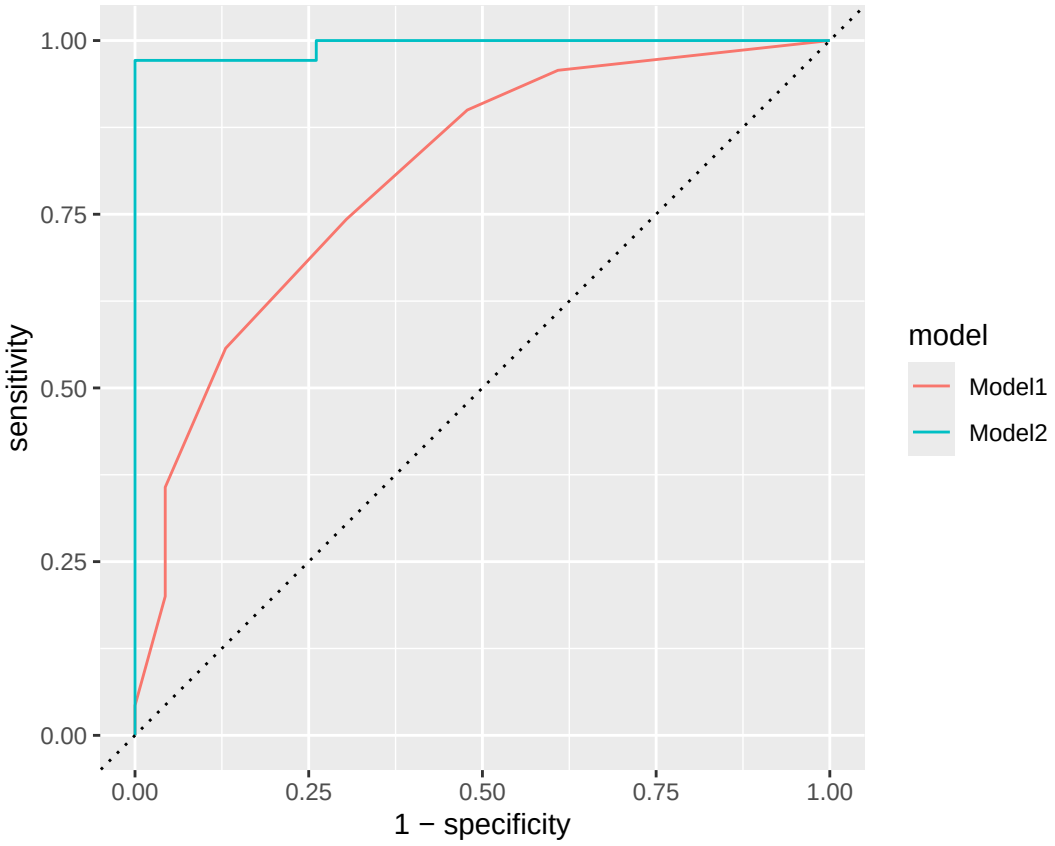


Figure 6: Comparing the Accuracy and Precision of both Models