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Statistical and Machine Learning Approaches to Investigate Adverse Effects of COVID-19 Vaccinations

Abstract

COVID-19 is still highly contagious and mutating in more viral, lethal variants. COVID-19 vaccines have been available to the general U.S. public for a majority of 2021 and reduced the hospitalization and death rates significantly. However, there are some adverse reactions to the vaccine cases that collect by U.S. Food & Drug Administration (FDA) and the Centers for Disease Control and Prevention (CDC) called 2021 VAERS Dataset [4]. In this study, we utilize different statistical approaches and machine learning classification algorithms in order to analyze VAERS Dataset and predict the likelihood of an adverse reaction based on various features such as age, gender, allergic history, taking other medications, type-2 diabetes, hypertension and heart disease.

Introduction

COVID-19 is still highly contagious and mutating in more viral, lethal variants. Even with recovery, many face complications after as COVID-19 – to include several mutated variants that cause respiratory infection and additional symptoms. COVID-19 vaccines have been available to the general U.S. public for a majority of 2021 and reduced the hospitalization and dead rate significantly. However, there are some adverse reaction to the vaccine cases that collect by U.S. Food & Drug Administration (FDA) and the Centers for Disease Control and Prevention (CDC) called 2021 VAERS Dataset [4]. In this research, different statistical approaches and machine learning classification algorithms utilized in order to determine the most efficient, accurate, and reliable in predicting the possibility of an Adverse Event (AE) from the administration of a vaccine based on set demographic categories and reported symptoms. The research provides detailed interpretation of the topmost common symptoms observed after administration of the vaccine that may have led to patient deaths based on age and gender, respectively.

Research Question(s)

- How common are breakthrough cases among vaccinated people?
- Given the evolving science, should people continue wearing masks after vaccination?
- What is the likelihood of an adverse reaction after vaccination based on a patient's medical history?
- Are there are groups of people who should consider alternatives to receiving the vaccine?

Materials and Methods

This study utilizes the 2021 VAERS "COVID-19 World Vaccination Progress Dataset" developed by the U.S. Food & Drug Administration (FDA) and the Centers for Disease Control and Prevention (CDC). The dataset contains the most relevant information on COVID-19 World Vaccination Progress and Events.

Machine learning techniques such as Naïve Bayes, Decision Tree, Random Forest, Multilayer Perceptron (MLP), and a few others were utilized in order to interpret which model will detect the highest accuracy in prediction of reported adverse events in the dataset [3]. Additionally, we applied different statistical approaches to visualize the dataset for further investigation.

Results

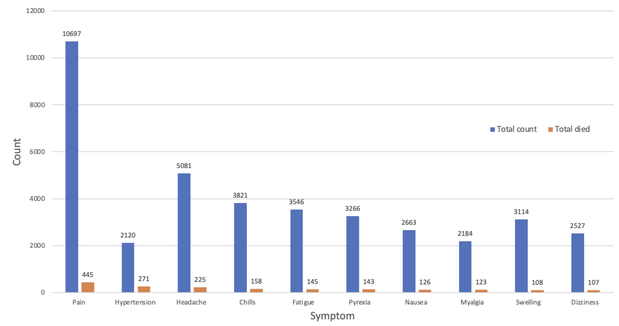

Fig. 1 Comparison of the total number of symptoms reported to the total number of deaths related to the symptom.

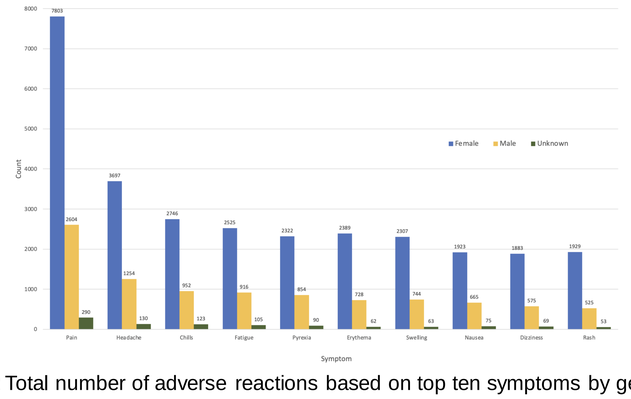

Fig. 2 Total number of adverse reactions based on top ten symptoms by gender.

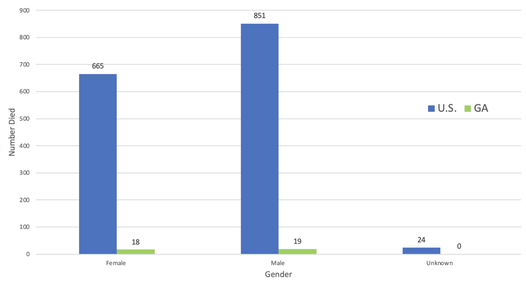

Fig. 3 Total number of deaths in GA compared to U.S. by gender.

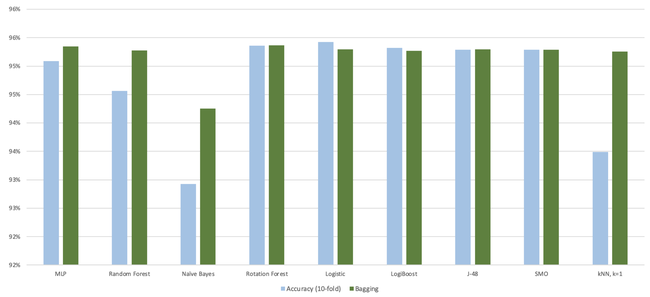

Fig. 4 Accuracy percentages on different machine learning models before and after applying Bagging technique. Naïve Bayes had the lowest accuracy and Logistic had the highest [1].

Conclusions

This experiment utilized reported reactions through the VAERS dataset [6] to predict mortality based on demographics such as age, gender, prior medical history, known allergies, and reported symptoms after administration of the vaccine.

The most common symptoms, as referenced in Figure 2, developed in patients as a result of COVID-19 vaccination are Pain, Headache, Chills, Fatigue, Pyrexia, Erythema, etc. Some of these same symptoms were also observed, as shown in Figure 1, in death related cases.

COVID-19 vaccines have shown to be effective so it is highly recommended people to be vaccinated. Patients with medical histories and allergies are also advised to discuss the possibility of vaccine reactions with their primary care physicians beforehand..

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