Modeling Recurrent Emergency Department Trends in the United States

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ABSTRACT
Emergency departments around the United States struggle with staff shortages and overcrowding following the COVID-19 pandemic and resulting shutdowns. This study aims to create and examine models representing the probability of patients requiring multiple emergency department visits during treatment to better understand why some patients require recurrent emergency department treatments. The two models considered in this experiment are the Poisson Process and the "Frequent Flyer" Hypotheses. Ultimately, analyzing the data provided by the National Center for Health Statistics revealed that the Poisson Process does not accurately represent the realities of recurrent emergency department visits, but the "Frequent Flyer" Hypothesis does in some situations. It also revealed that there may be several lurking variables that compound to determine if a patient will require multiple emergency department visits, accounting for the inconsistencies of the "Frequent Flyer" Hypothesis.

KEYWORDS
Recurrent Emergency Room Visits; Repeated and Frequent Emergency Department Visitors; Overcrowding; Emergency Department; Poisson Process; Frequent Flyers; Mathematical Modeling; Healthcare Management; Healthcare Outcomes

INTRODUCTION

The emergency room started with four physicians in 1961 but has grown to see hundreds of millions of patients yearly in the United States alone.[1] Even after the development of urgent care facilities, which generally decrease the number of emergency department visits necessary per year,[2] the emergency department continues to play a crucial role in the American healthcare system. This paper will explore why people go to the emergency department and, more specifically, investigate why some people require multiple emergency department visits yearly.

Healthcare workers who specialize in emergency medicine are known for treating car crash injuries, gunshot wounds, broken bones, heart attacks, strokes, and other potentially fatal conditions. However, according to the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project, patients in 2018 also sought help treating abdominal pain, digestive disorders, respiratory infections, urinary tract infections, skin infections, nausea and vomiting, pregnancy complications, and viral infections.[3]

Unfortunately, the recent COVID-19 pandemic proved how fragile the US healthcare system can be, but no department was hit quite as hard as the Emergency Department. While the total number of patients seen in emergency departments decreased during the pandemic, the number of patients with urgent and emergent conditions increased dramatically, forcing patients to wait much longer for adequate treatment because of unprepared hospitals and a phenomenon called overcrowding.[4]

Overcrowding, as defined by the American College of Emergency Physicians, occurs when there is a larger demand for emergency treatment than can be provided by the current emergency department staff and resources.[5] To begin solving this problem, it is essential to understand not only why people go to the emergency department but also why some of those patients will require multiple visits.

Researchers and healthcare administrators have been investigating emergency department overcrowding and have deduced that many structural insufficiencies may account for its recent increase: lack of access to primary care, triage and consultation time, delays in receiving test results, declining numbers of ER and hospital beds, and staffing shortages.[6] For example, 84% of emergency department nurses have an inflated patient-to-nurse ratio of 4:1 according to the American Nursing Association, which decreases their performance and leads to stress and job burnout.[7] Unfortunately, this often causes nurses to quit, worsening the problem.[6]

The National Center for Health Statistics, a branch of the Centers for Disease Control and Prevention,[8] has collected data showing that over the last twenty-six years, a significant portion of the population has required multiple emergency department visits yearly.[9] While emergency medicine physicians may not be able to control outside factors like the number of emergencies that will occur, the number of patients that will arrive at the emergency department at any given time, and the time it takes to consult, diagnose, and treat patients properly,[6] they should take the time to determine why so many of their patients require multiple visits to be appropriately cared for and treated.

Researchers have been analyzing the significant amount of emergency department data collected across the globe for decades. Recently, they have begun to investigate the characteristics of recurrent emergency department patients and determine what increases the likelihood of a patient needing multiple visits. One study in Switzerland discovered two types of ED patients: "frequent" patients who presented with different symptoms each visit and "repeated" patients who returned with the same symptoms each time.[10]

The National Center for Health Statistics conducts a National Health Interview Survey where they ask approximately 87,500 noninstitutionalized American civilians,[11] "During the past 12 months, how many times have you gone to a hospital emergency room about your own health?" and to include emergency department visits that resulted in hospital admissions.[12] This data has been collected from 1997 to 2019 and processed according to the associated US Census data to determine the appropriate standard errors.[11] The calculated response rates were used to estimate the total percentage of the US population who had gone to an emergency department each year.[11] Then, the data were broken down into two main groups: people who went to the emergency department one or more times that year and people who went to the emergency department two or more times that year.[9]

This research aims to create models that will analyze the data by examining the different processes that may contribute to the percentage of recurrent patients treated in the emergency department yearly. This paper will first begin by describing the original data set. Then, it will explain the development and investigation of the two original hypotheses. Finally, it will discuss an interpretation of the data, explore possible explanations for these results, and suggest areas that may benefit from additional research.

METHODS AND PROCEDURES

Visualizing the data

A scatter plot of the raw values was created to begin visualizing the data provided by the National Center for Health Statistics. It became apparent that there were three main clusters in the data: one representing the group of patients who visited an emergency department one or more times per year, another representing the group of patients who visited an emergency department two or more times per year, and the final group representing the standard errors for each percentage calculated by the National Center for Health Statistics. By removing the standard error values, the two different clusters could be plotted as two separate lines, with the x coordinate representing the year the data was collected from and the y coordinate representing the percentage of people in each category. While the data originally appeared random, it became clear that the percentage of patients requiring recurrent emergency department visits was consistently smaller than that of patients requiring one or more visits.

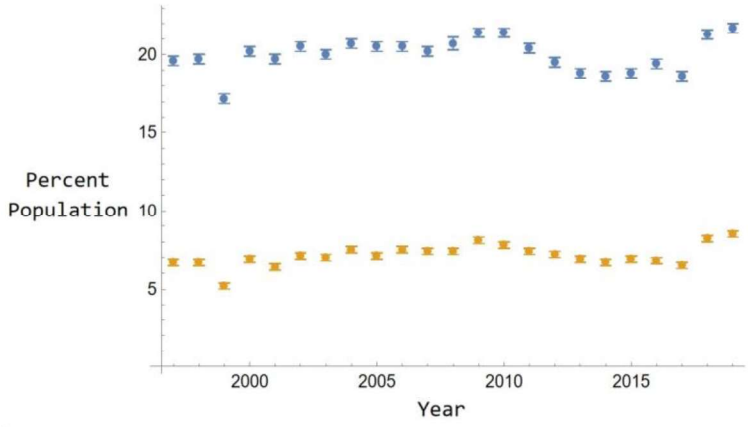

Figure 1. Examining the Percentage of Patients Requiring Single and Multiple Emergency Department Visits Every Year. This graph represents the trends of patients requiring single and multiple emergency department visits from 1997 to 2019, with error bars related to the standard errors determined by the Centers for Disease Control and Prevention's National Center for Health Statistics. The blue data represents the percentage of patients requiring one or more emergency department visits per year, while the orange data represents the percentage of patients requiring two or more emergency department visits per year.

Many different processes can be used to model this data. One way to predict emergency department visits would be to use the Poisson Process. This mathematical model demonstrates the likelihood of random events occurring.[13] For example, it has been used to determine the duration of a wait time for a soda at McDonald's, the chances of a substance suffering from radioactive decay, and the arrival time of public transportation.[13] Another model, the Bernoulli Process, can show a similar series of independent and identical events.[14] However, there may be several outside factors that influence whether a patient decides to go to the emergency department or not, meaning a new model may need to be developed to properly represent the complexity of emergency department visits.

Considering these models, two main hypotheses could explain this data. Hypothesis 1, **the Poisson Hypothesis**, states that all trips to the emergency department result from random events that are independent and rare. However, Hypothesis 2, **the Frequent Flyer Theory**, states that there are likely two groups of people: one that only goes to the emergency department when random, independent, and emergent events occur and one that consistently goes to the emergency department and is nicknamed the "frequent flyers."

Modeling the Poisson Process

Because the data was broken down into people who went to the emergency department one or more times a year and those who went to the emergency department two or more times a year, the second group was contained entirely within the first group. The percentage of people who went two or more times a year was subtracted from the percentage of people who went one or more times a year, leaving only the isolated group of people who went to the emergency department once a year. The data was then transposed into coordinate pairs where the x coordinate represented the percentage of the population who only went to the emergency department once per year while the y coordinate represented the percentage of the population who went to the emergency department two or more times per year.

To determine the validity of the Poisson Hypothesis, two equations were created to represent the Poisson Process. The first function, referred to as **Equation 1**, is

$$n\,p\,(1-p)^{n-1} = p_0 \qquad \textbf{Equation 1.}$$

where n equals three-hundred-sixty-five, and p_0 equals the percentage of the population the National Center for Health Statistics recorded as going to the emergency department once.

This equation can then be solved for p, which represents the daily probability of someone going to the emergency department exactly once a year. This equation does have multiple solutions for p. However, a single solution can be derived by limiting the solutions to values that fall between zero and approximately 0.0027, which is equivalent to 1/365 and represents the chance of going to the emergency department on exactly one day out of the three-hundred-sixty-five days in one year. These restrictions allow a single solution to be derived by the Mathematica program for the development of the Poisson Hypothesis model.

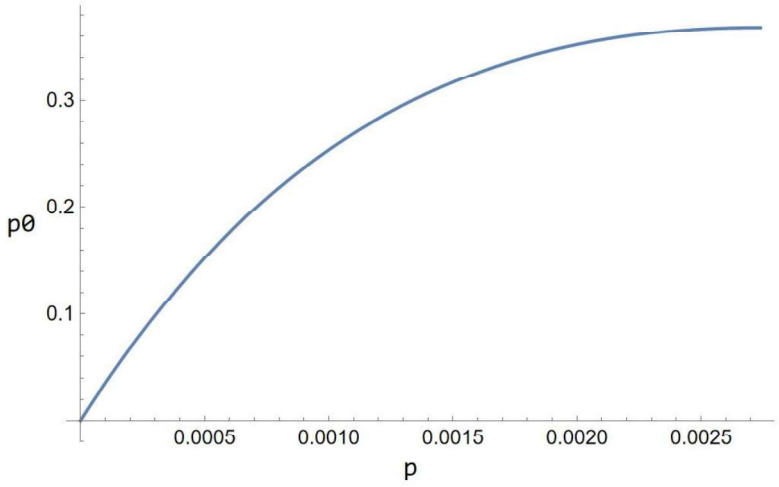

Figure 2. Proving the Validity of Equation 1. This graph demonstrates that there is only one solution to **Equation 1** when p is restricted to values that fall between zero and 1/365 (approximately 0.0027).

The second function, referred to as **Formula 1**, is

$$1 - (1 - p)^n + n\,p\,(1 - p)^{n-1}$$ **Formula 1.**

where n equals the number of days from one to three-hundred-sixty-five and p equals the daily probability of a person needing to go to the emergency department only once a year for an independent emergency. When using the calculated p from **Equation 1**, this formula can be evaluated to determine the probability of a person going to the emergency department two or more times a year.

Modeling the Frequent Flyer Theory

The Frequent Flyer Theory suggests that there are two different populations: "frequent flyers," or patients who visit the emergency department often due to chronic physical, mental, or social issues,[15] and "non-frequent flyers," or people who only seek out emergency medical care during an actual emergency, if at all.

To evaluate the validity of this theory, mathematical models were created using the Poisson Process to represent the probability of four different scenarios. These included the daily probability of non-frequent flyers seeking emergency medical treatment, the probability of an individual going to the emergency department exactly once a year, the probability of an individual not requiring an emergency department visit at all over a year, and the probability of an individual requiring more than one emergency department visit per year.

In our models, we defined two different populations, p_1 and p_2, as the following:

$$p_1 = h * q$$ **Equation 2.**

$$p_2 = f + g * q$$ **Equation 3.**

where p_1 is the percentage of people who go to the emergency department only once, p_2 is the percentage of people who go to the emergency department more than once, h is the probability of someone going to the emergency department exactly once according to the Poisson Process, q is the proportion of people that are not considered frequent flyers, f is the proportion of people who are considered frequent flyers, and g is the probability that someone goes to the emergency department more than once according to the Poisson Process. By understanding how f can be defined using these variables, the following equation is derived:

$$\frac{p_1}{h} = \frac{(1-p_2)}{(1-g)}$$ **Equation 4.**

By substituting 1 - g with α + h, where α represents the probability of someone not visiting the emergency department at all according to the Poisson Process, and isolating p_1 and p_2 on one side of the equation:

$$\frac{(\alpha+h)}{h} = \frac{(1-p_2)}{p_1}$$ **Equation 5.**

By simplifying this equation and substituting variables with their definitions:

$$\frac{\alpha}{h} = \frac{(1-(p_1+p_2))}{p_1} = \frac{(1-\alpha)}{(365\alpha)} = x$$ **Equation 6.**

where x is a useful variable that will simplify the following equations. This equation can then be used to derive the daily probability of a person requiring an emergency department visit when that person is not considered a "frequent flyer" using the following equation:

$$a = \frac{1}{(1+365x)}$$ **Equation 7.**

Using **Equation 7**, a new equation, represented by h, can be derived to determine the probability of an individual going to the emergency department exactly once a year, as dictated by the Poisson Process. This equation is:

$$h = 365a\,(1 - a)^{364}$$ **Equation 8.**

Equation 7 can also be used to derive a new equation, represented by α, to calculate the probability of an individual not needing to visit the emergency department for a year, as dictated by the Poissonα Process. This equation is:

$$\alpha = (1 - a)^{365} \quad \textbf{Equation 9.}$$

Equation 7 can also be used to derive a separate equation, represented by g, to calculate the probability of an individual requiring multiple emergency department visits within a year, as dictated by the Poisson Process. This equation is as follows:

$$g = 1 - (h + \alpha) \quad \textbf{Equation 10.}$$

Equations 7 and 8 can then be used to derive a new equation, represented by q, to calculate the proportion of the population not considered "frequent flyers." This new equation is:

$$q = \frac{p_1}{h} \quad \textbf{Equation 11.}$$

Finally, **Equation 11** can be used to derive an equation, represented by f, that can calculate the proportion of the population that is considered "frequent flyers." This equation is:

$$f = 1 - q \quad \textbf{Equation 12.}$$

Equation 12 is what was ultimately used to create the scatter plots seen below.

RESULTS

Testing the Poisson Process

To visualize these processes and compare them to the actual data, **Formula 1** was plotted as a function of **Equation 1** on a graph, with the x-axis representing the percentage of the population who only went to the emergency department once per year and the y-axis representing the percentage of the population who went to the emergency department two or more times per year. Once the continuous curve representing the Poisson Process was plotted, the National Center for Health Statistics data was plotted for comparison and is shown below.

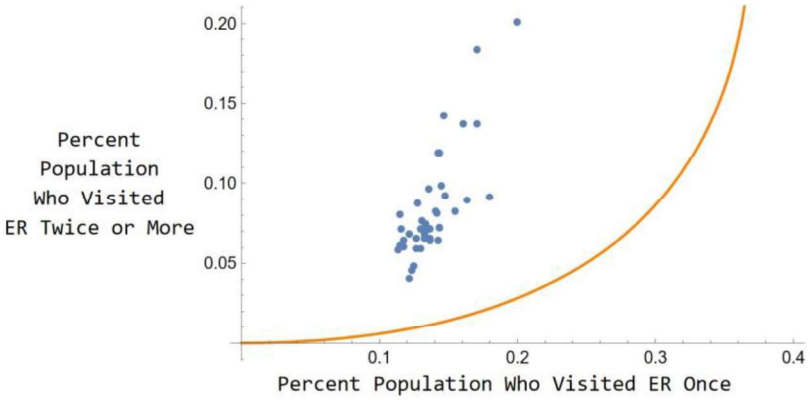

Figure 3. Testing the Poisson Hypothesis. This graph compares the data from the National Center for Health Statistics and the predicted data described by the Poisson Process. The blue line represents the raw data, while the orange line represents the hypothesized Poisson Process trend.

A Chi-Square Goodness of Fit test with one degree of freedom and a sample size of 87,500[11] was performed. The smallest t-statistic calculated was 7,363.78. The Mathematica program could not calculate an exact p-value from this t-statistic because the resulting answer is smaller than the smallest machine number. However, it reported the value as less than e^{-3686}, indicating that $p < 10^{-1600.81}$.

Testing the Frequent Flyer Theory

Equation 6 was incorporated into another function, **Frequent Flyer Proportion**, which subtracted the percentage of people who went to the emergency department two or more times from the percentage of people in each category who went one or more times, leaving only the percentage of people who went to the emergency department exactly once. This function generated p_1 and p_2 values that could be used in the Frequent Flyer model.

Plugging these values back into **Equation 6** provided the x value that served as the foundation for the Frequent Flyer model. Each subsequent equation was solved using the variable calculated by the equation before it. **Equation 12** ultimately allowed the percentage of people in each category that could be classified as a "frequent flyer" to be calculated. The resulting values were then arranged into coordinate pairs where the x value represented the year from 1997 to 2019 and the y value represented the percentage of people classified as frequent flyers.

Testing frequent flyer covariates

In addition to being broken down by year, the data provided by the National Center for Health Statistics was also broken down according to various patient demographics, including age, sex, percentage of the poverty level, type of insurance, geographic region, and location of residence. The graphs produced by the Frequent Flyer Model were sorted according to these demographics to see if these characteristics influence the presence of "frequent flyers" in a population.

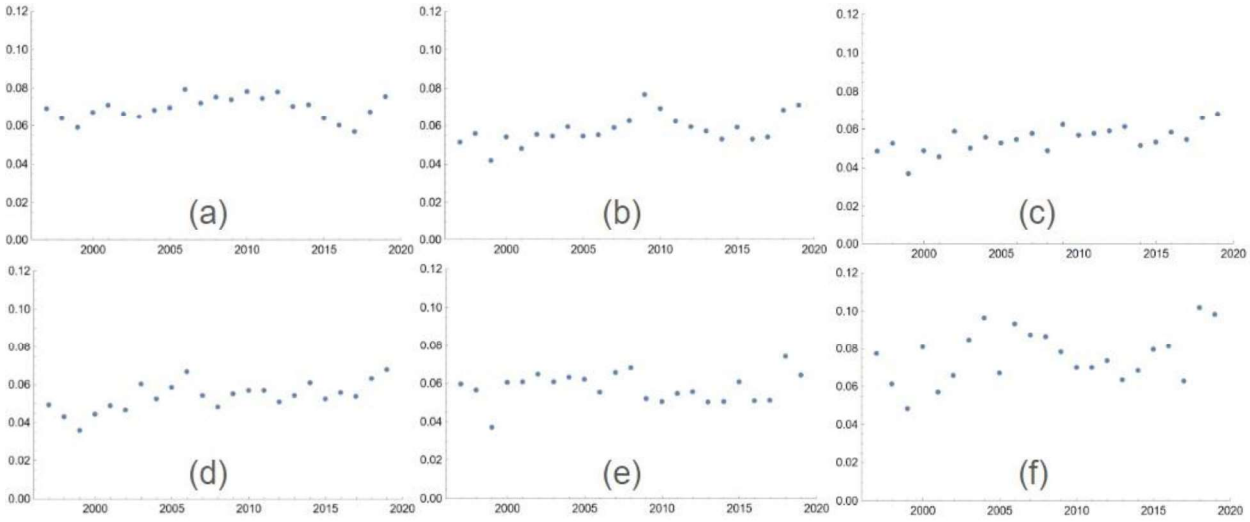

Figure 4. The Frequent Flyer Theory and Age. These scatter plots demonstrate a relationship between time and the percentage of patients who are deemed annual "frequent flyers" in different age groups, including (a) 18 to 24-year-olds, (b) 25 to 44-year-olds, (c) 45 to 54-year-olds, (d) 55 to 64-year-olds, (e) 65 to 74-year-olds, and (f) 75-year-olds and older. In each graph, the x-axis represents the year, and the y-axis represents the percentage of people who go to the emergency department two or more times a year.

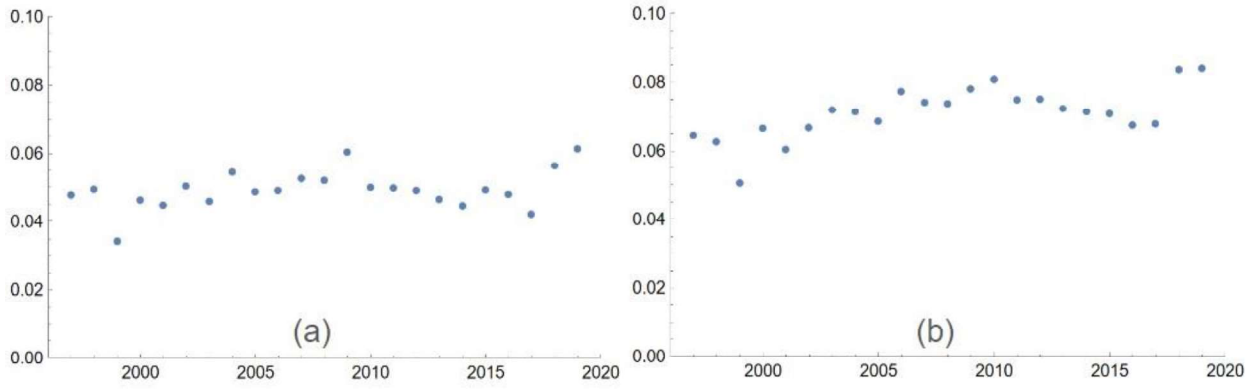

Figure 5. The Frequent Flyer Theory and Sex. These scatter plots demonstrate a relationship between time and the percentage of the population who are deemed annual "frequent flyers" when considering patients who differ according to their biological sex, including (a) males and (b) females. In each graph, the x-axis represents the year, and the y-axis represents the percentage of people who go to the emergency department two or more times a year.

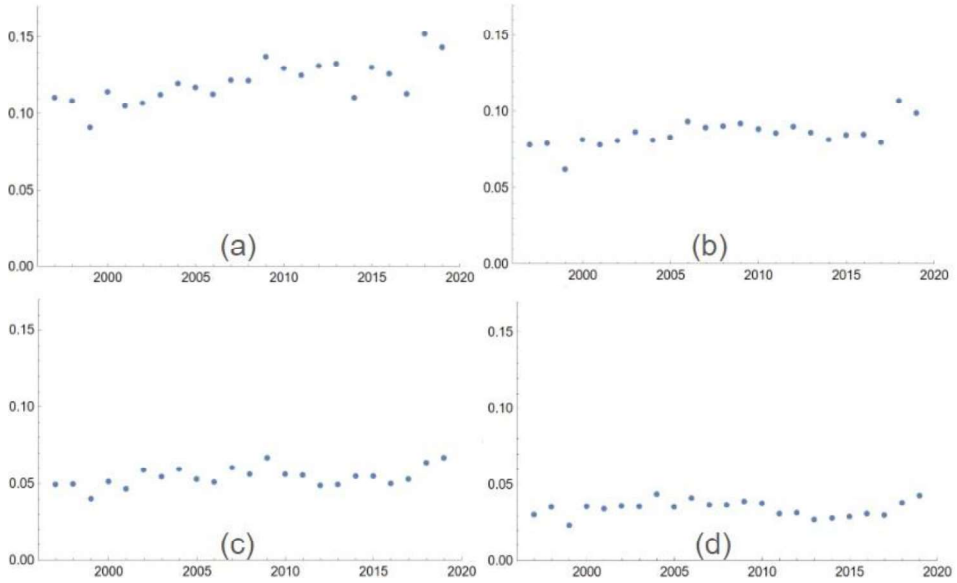

Figure 6. The Frequent Flyer Theory and Percentage Poverty Level. These scatter plots demonstrate a relationship between time and the percentage of the population who are deemed annual "frequent flyers" when patients fall within different percentages of the poverty level, including (a) below 100%, (b) between 100%-199%, (c) between 200%-399%, and (d) 400% or more. In each graph, the x-axis represents the year, and the y-axis represents the percentage of people who go to the emergency department two or more times a year.

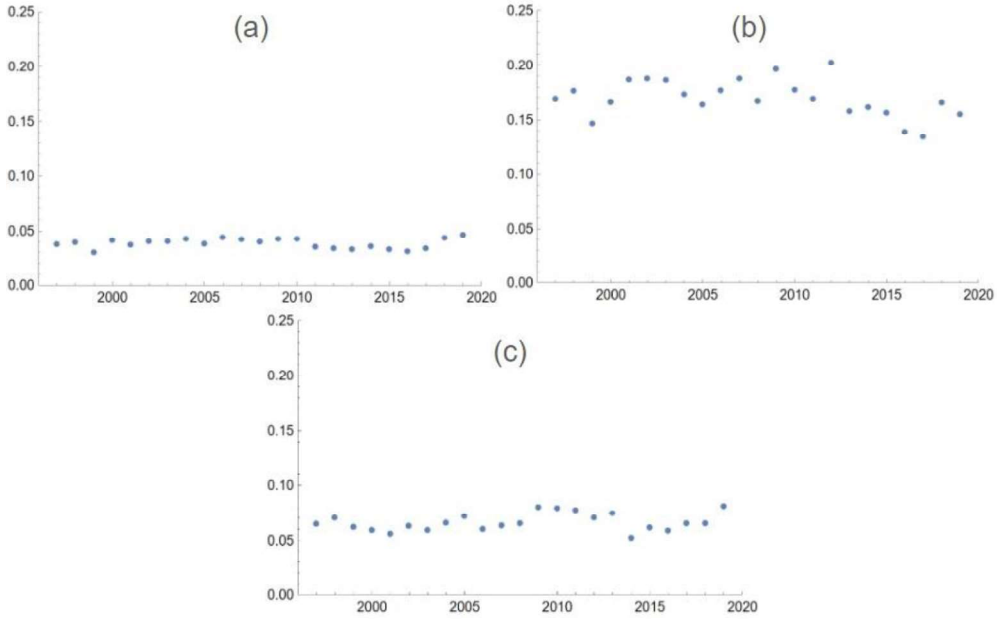

Figure 7. The Frequent Flyer Theory and Type of Insurance. These scatter plots demonstrate a relationship between time and the percentage of the population who are deemed annual "frequent flyers" when patients have different types of insurance, including (a) private insurance, (b) Medicaid, and (c) no insurance. In each graph, the x-axis represents the year, and the y-axis represents the percentage of people who go to the emergency department two or more times a year.

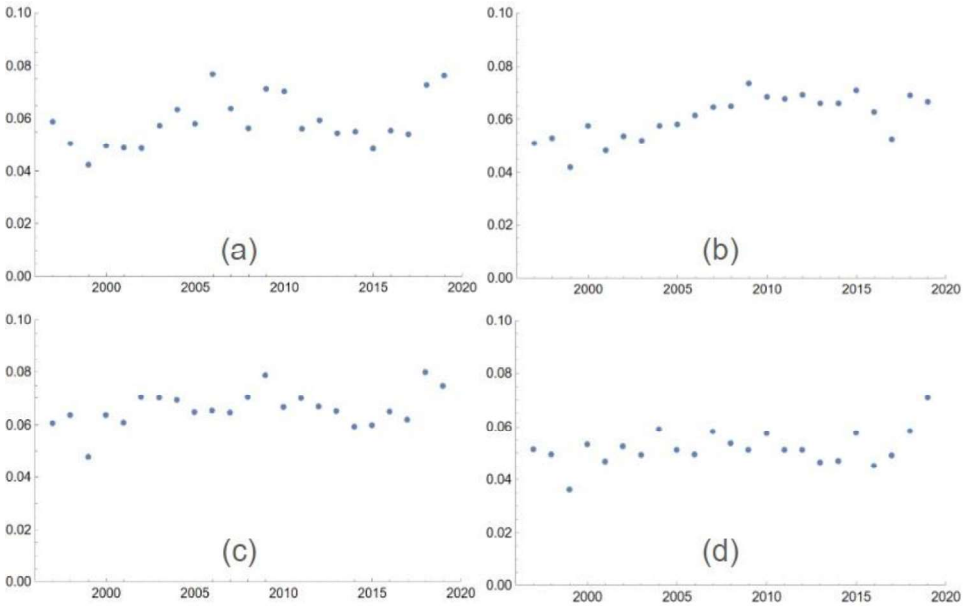

Figure 8. The Frequent Flyer Theory and Geographic Region. These scatter plots demonstrate a relationship between time and the percentage of the population who are deemed annual "frequent flyers" when patients live in different geographical regions, including the (a) northeast, (b) midwest, (c) south, and (d) west. In each graph, the x-axis represents the year, and the y-axis represents the percentage of people who go to the emergency department two or more times a year.

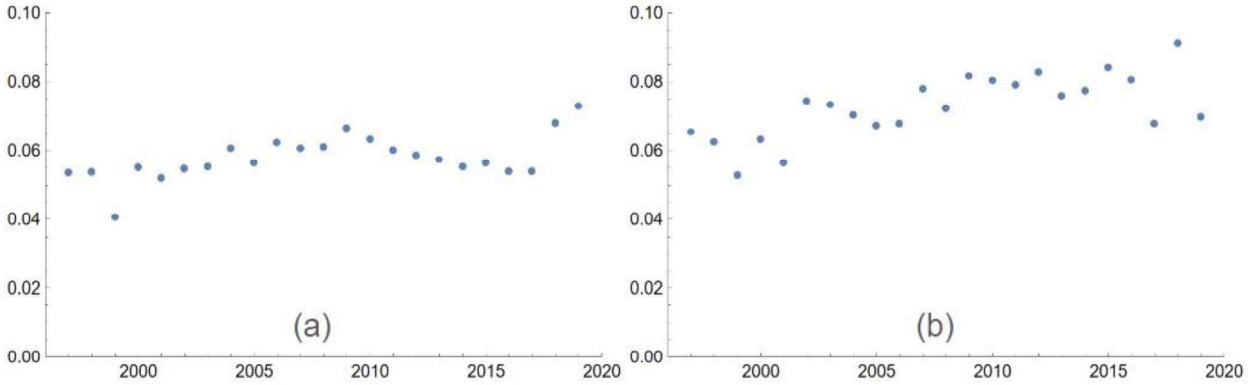

Figure 9. The Frequent Flyer Theory and Location of Residence. These scatter plots demonstrate a relationship between time and the percentage of the population who are deemed annual "frequent flyers" when patients differ according to how close they live to urban areas, including (a) those who live in or close to a city (within an MSA) and (b) those who do not live in or close to a city (outside an MSA). In each graph, the x-axis represents the year, and the y-axis represents the percentage of people who go to the emergency department two or more times a year.

DISCUSSION

Analysis of mathematical models

The data did not follow trends predicted by the Poisson Curve. Instead of following the hypothesized gradual curve, the data formed a straight line with a much steeper positive slope. Even manipulating and enlarging the curve to make the hypothesized line appear straight did not help the raw data align with the theoretical curve. The raw data points were also plotted significantly higher on the y-axis than the Poisson Curve suggested they should be. The incredibly large t-statistic and minuscule p-value calculated through the Chi-Square Goodness of Fit Test confirmed that this model could not accurately predict recurrent emergency department visit trends. Because of these reasons, the Poisson Process is not a good model for the National Center for Health Statistics data and should be rejected as the null hypothesis.

The data followed the Frequent Flyer Model much better in some cases, as represented by the nearly horizontal trendlines in some covariate graphs above, indicating that the percentage of "frequent flyers" in these populations remains relatively constant from year to year. However, this hypothesis still did not adequately represent the reality of the emergency department in all cases,

as demonstrated by the non-horizontal trendlines and random scatter of sporadically increasing or decreasing data points seen in other covariate graphs above. These observations indicate that the percentage of "frequent flyers" in these populations fluctuates as time passes. Random but short periods of dramatic increasing or decreasing frequent flyer percentages could mean that other lurking variables likely impact these values. Possible lurking variables that were not considered in our mathematical models but may require further investigation will be discussed below.

Analysis of frequent flyer covariates

Qualitative analysis of the covariate graphs generated above allows us to understand the relationship between the Frequent Flyer Theory and the covariates collected in the data. When considering age, the Frequent Flyer Theory best represents patients 18 to 24 years old (**Figure 4a**) and 65 to 74 years old (**Figure 4e**) who require multiple emergency department visits per year. The trendlines present in **Figures 4a** and **4e** are generally horizontal, indicating that a consistent proportion of the population requires multiple emergency department visits per year regardless of how much time passes. This proportion consists of the "frequent flyers" and is consistent with the Frequent Flyer Theory. The proportion of frequent flyers seen in patients between the ages of 18 and 24 is slightly larger than the proportions seen in other age groups.

The trendlines in **Figures 4b**, **4c**, and **4d** generally have a positive slope, indicating that the proportion of the population requiring recurrent emergency department visits increases as time passes in patients ages 25 to 44 (**Figure 4b**), 45 to 54 (**Figure 4c**) and 55 to 64 (**Figure 4d**). This finding is not consistent with the Frequent Flyer Theory. **Figure 4f**, which represents patients 75 years and older, is also inconsistent with the Frequent Flyer Theory because its data points randomly increase and decrease as time passes without following a general pattern. Some of the largest recorded proportions of patients requiring recurrent emergency department visits in one year are seen in patients 75 years or older.

When considering sex, the Frequent Flyer Theory seems to best represent male patients who require multiple emergency department visits per year. The trendline in **Figure 5a** is generally horizontal, indicating a consistent proportion of male patients who require recurrent emergency department visits yearly and act like "frequent flyers" from year to year. Conversely, the trendline in **Figure 5b**, which represents female patients who require recurrent emergency department visits yearly, is not horizontal. It has a generally positive slope, indicating that the proportion of female patients who require multiple emergency department visits yearly increases as time passes. This is not consistent with the Frequent Flyer Theory. It also appears that more female patients require recurrent emergency department visits per year than male patients.

When considering poverty, the Frequent Flyer Theory is good at describing the existence of frequent flyers in various populations. **Figures 6b**, **6c**, and **6d**, which represent people who fall between 100% and 199% of the poverty level, 200% and 399% of the poverty level, and 400% or more of the poverty level, respectively, generally have horizontal trendlines. These trendlines indicate that consistent proportions of these populations require multiple emergency department visits every year and act like "frequent flyers" from year to year. However, **Figure 6a**, which represents people who fall below 100% of the poverty level, has a positive trendline, indicating that the proportion of the population that requires multiple emergency department visits per year increases as time passes. This is not consistent with the Frequent Flyer Theory. It also appears that a larger proportion of patients require recurrent emergency department visits when they fall below 100% of the poverty level (**Figure 6a**) as compared to other populations.

When considering the type of insurance patients have, the Frequent Flyer Theory best describes the need for recurrent yearly emergency department visits in patients who have private insurance (**Figure 7a**). The trendline in **Figure 7a** is nearly completely horizontal with little variation in data points, indicating that a consistent population of privately insured individuals seek recurrent emergency department visits from year to year and act as "frequent flyers." The Frequent Flyer Theory is also reasonably consistent with **Figure 7c**, which represents uninsured people. There is slightly more variation in this primarily horizontal trendline as compared to **Figure 7a**, and it also shows a slightly larger proportion of uninsured patients requiring recurrent emergency department visits as compared to privately insured patients. The Frequent Flyer Theory is not consistent with **Figure 7b**, which represents patients with Medicaid. This trendline is not horizontal. Instead, data points randomly increase and decrease from year to year. These data points are also significantly larger than those seen in **Figures 7a** and **7c**.

When considering geographic regions, the Frequent Flyer Theory does not describe the proportion of patients requiring multiple emergency department visits every year in the northeast (**Figure 8a**), midwest (**Figure 8b**), south (**Figure 8c**), or west (**Figure 8d**). None of the trendlines in **Figures 8a**, **8b**, **8c**, or **8d** are horizontal. Instead, they all seem to have positive non-zero slopes. This indicates that the proportion of these populations requiring recurrent emergency department visits every year increases as time passes. This finding is not consistent with the Frequent Flyer Theory.

Finally, when considering patients' residential location, the Frequent Flyer Theory does not describe the proportion of patients requiring multiple emergency department visits in urban areas within MSAs (**Figure 9a**) or rural areas outside MSAs (**Figure 9b**). **Figures 9a** and **9b** do not have horizontal trendlines. Instead, they have positive, non-zero trendlines, indicating that the proportion of these populations requiring recurrent emergency department visits increases as time passes. This is not consistent with the Frequent Flyer Hypothesis. However, it does seem that there is a larger proportion of people requiring recurrent emergency department visits in rural areas located outside of MSAs than in urban areas within MSAs.

Analysis of possible causes of frequent flyers and additional lurking variables

In addition to dire emergencies, there are many reasons why patients may need to have repeat visits to the emergency department that might explain the existence of frequent flyers or the potential lurking variables invalidating the Frequent Flyer Model in certain populations. For example, some medical conditions require specialized treatment only the hospital can provide due to their serious nature.[12] These conditions may require hospital intervention to return patients to their baseline, especially when their conditions are not adequately managed at home.[16, 17] Other patients may have certain risk factors that make them prone to requiring emergency treatment, such as having a substance abuse disorder [18, 19] or being an inexperienced or reckless driver.[19] Still, some patients may get sick or injured at night or on weekends when their primary care physician is not working or be unable to schedule an appointment when these things occur during normal business hours.[12] All of these situations may cause patients to seek treatment in emergency departments even when "emergencies" have not occurred.

People may also choose to go to the emergency department instead of their primary care physician if they cannot afford healthcare insurance or office visits but still need treatment. Since Congress passed the Emergency Medical Treatment and Active Labor Act (EMTALA) in 1986, the emergency department has been required to treat all patients regardless of their ability to pay for their services.[20] Primary care physicians are not required to follow this law because they are considered private businesses.[21, 22] Patients who choose to replace their primary care provider with the emergency department can be seen multiple times a year depending on how often they develop various medical conditions.

Still, patients may develop conditions that require a specialist to diagnose and treat them. Sometimes, these specialists can have full schedules, preventing patients from being seen quickly. Even if patients can be seen by the specialists, they may not be able to schedule elective procedures or surgeries soon enough. When this happens, patients may be left with no choice other than to go to the emergency department to receive faster, and sometimes temporary, treatment. Moreover, while waiting to see specialists for diagnosis or treatment, their condition may progress from chronic to acute, requiring emergent intervention.

Overprescribing narcotic pain relievers in healthcare has led to the development of patients with drug-seeking behaviors, or patients who are addicted to substances that they cannot readily acquire, causing them to speak and act in ways that will convince healthcare providers to prescribe and administer their drug of choice.[23] This epidemic began in the 1990s when healthcare professionals began overprescribing narcotic pain relievers when drug companies misrepresented the medications' addictive qualities.[24] As a result, hundreds of thousands of emergency department visits occur unnecessarily as some patients seek a reliable source of narcotics.[24]

Some patients also require multiple emergency department visits because they cannot tell when they are sick enough to constitute emergent medical intervention.[15] It is common for young patients ranging in age from toddlers to young adults to visit the emergency department for already-healing insect bites or the flu.

Sometimes, patients may discover something abnormal or develop new symptoms and need reassurance from a doctor. However, patients who cannot be consoled by negative tests and discussions with their doctors may have an illness anxiety disorder. This disorder occurs when patients needlessly believe that they are or are about to become sick and seek unnecessary treatment.[25] Erving Goffman's Role Theory may also explain some of these recurrent emergency department visits. According to Goffman, people are assigned various roles throughout their lives that dictate how they interact with other individuals and society.[26] In this case, if a person believes their role in society is to be a patient, they may be more inclined to seek healthcare, even unnecessarily, since that is what patients are expected to do. The reasons discussed in this section should be further explored to better understand the applications and limitations of the Frequent Flyer Theory model.

CONCLUSIONS

Even though the data from the National Center for Health Statistics aligns with some characteristics of each hypothesis while disproving other parts, it is more likely that the Frequent Flyer Theory correctly depicts the reality of the emergency department. However, the reasons for some of the inconsistencies among various covariates remain unknown.

These models have some limitations. One limitation is that they were created from a small data set containing only slightly more than twenty data points. There may not have been enough data to represent the emergency department accurately. Another limitation is that there are several social and emotional factors that may lead a patient to require multiple emergency department visits that are not considered true emergencies or "frequent flyer" behavior. These situations were not considered in these models and may explain some of the inconsistencies discovered in the Frequent Flyer Theory model.

Future research is necessary to determine why there is considerable variability among recurrent emergency department visits from year to year. Researchers should also investigate how the potential explanations of recurrent emergency department visits detailed in the *Discussion* section work together to create the overflow of recurrent patients observed in the emergency department. Answering these questions will help emergency medicine physicians avoid overcrowding and provide better care to patients who come to the emergency department.

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The data analyzed in this project can be downloaded using the following link (March 2025):
https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Publications/Health_US/hus20-21tables/edad.xlsx

Conflict of Interest/Protection of Persons

The author declares no conflict of interest. All patient and participant data were protected in accordance with the regulations set forth by the Centers for Disease Control and Prevention.

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PRESS SUMMARY

The purpose of this study is to create models that can accurately depict the likelihood of patients requiring multiple emergency department visits to better understand when and why patients will require multiple emergency department visits to heal completely. These models were created by analyzing data from the National Center for Health Statistics at the Centers for Disease Control and Prevention. They will be useful since emergency departments in the United States became busier while struggling to staff enough medical professionals to care for the influx of patients following the COVID-19 pandemic. The analysis revealed that while the theory that some patients require recurrent emergency department visits due to various physical and social needs accounted for the percentage of recurrent emergency department visits in the United States better than the theory that all emergency department visits occur by random chance, there may be additional reasons not considered in these models that should be considered in the future.