Analyzing Gender, Age, State, and Organ Type Impacts on Waitlist Status

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***Abstract*—Based on gender, age, state, and type of organ transplant needed, how likely are certain groups within these variables (in the USA) to be on a transplant waitlist? Researching organ donation waitlists and trends is important because those waiting for transplants are often in the later stages of organ disease or failure. By researching the process of organ donation waitlists we are able to understand how recipients and their families are affected. Our model could be used by individuals and corporations within the healthcare system who are part of the organ transplant process, as well as those who work within the Organ Procurement & Transplantation Network (OPTN) as they are the sole organization in the United States responsible for managing organ transplant lists. It would benefit those who are on the waiting list as it would encourage OPTN to reconsider and improve their organ transplant process, hypothetically leading to shorter waiting times and increased equity in access to organ transplants. With the use of datasets from HRSA [1] and UNOS [2], we will look for correlations between our four predictors (gender, age, state, and type of organ transplant needed) and the likelihood that they are on an organ donation waitlist.**

***Keywords*—organ donation, gender, age, type of organ transplant, Organ Procurement & Transplantation Network (OPTN), waitlist**

I. INTRODUCTION

There are over 103,000 individuals currently on the national organ transplant waiting list, and every 8 minutes, another person is added to the waiting list. 17 people die each day waiting for an organ transplant [3]. The United States' organ transplant system is managed solely by the United Network for Organ Sharing (UNOS), a private, nonprofit organization, through the Organ Procurement and Transplantation Network (OPTN) under contract with and overseen by the federal government. This monopoly raises concerns about the equity of the organ transplantation process and calls into question if and how individuals' characteristics make them more likely to end up on an organ donation waitlist. Gender, age, state, and the type of organ transplant needed were identified as critical predictors in determining if an individual would be on the waiting list. UNOS' goals of increasing organ utilization, enhancing process efficiency, and especially improving equity in access to transplants could benefit from our findings, which show that overall, kidney transplants are the most commonly sought-after type of transplantation with liver transplants as the second most requested. In addition to this, we were also able to determine that women tend to occupy more candidates on transplant waitlists than men.

II. METHODOLOGY

The features we used in our analysis were gender, age, state, and type of organ transplant. We used these particular features as our predictor features in order to determine if there is a relationship between these demographic

characteristics and whether someone is on an organ transplant waitlist or not, which was our response. We looked at the mean when analyzing age and mode when analyzing gender, state, and type of organ transplant. Throughout the dataset, there were rows that were left completely blank which we removed. Our distributions are not skewed, despite kidneys being the most requested organ across all states.

For our data cleaning process, the ‘Unnamed: 3’ column was removed as it was completely empty. The 'Kidney / Pancreas', 'Heart / Lung', 'Intestine', 'Abdominal Wall', 'VCA - head and neck', 'VCA - upper limb', and 'VCA - uterus columns were removed due to being combinations of other columns (fx. Kidney / Pancreas vs. Kidney, Pancreas). All empty rows were removed as well as rows containing information related to Puerto Rico and the District of Columbia, as we only looked at states and not territories or districts. We also removed rows containing ‘All Genders’ or ‘All Ages’ to avoid any double counting. After the removal of empty rows, and entries related to the District of Columbia and Puerto Rico, the number of rows available for analysis decreased from 1161 to 609, represented in Figure 1.

	State	Age_Group	Gender	All Organs	Kidney	Liver	Pancreas	Heart	Lung
31	Alabama	< 1 Year	Female	1	0	0	0.0	1	0.0
33	Alabama	1-5 Years	Male	5	2	2	0.0	1	0.0
34	Alabama	1-5 Years	Female	8	2	3	0.0	3	0.0
36	Alabama	6-10 Years	Male	1	0	0	0.0	1	0.0
37	Alabama	6-10 Years	Female	1	1	0	0.0	0	0.0
...	...	...	...	...	...	...	...	...	...
1155	Wisconsin	35-49 Years	Female	126	98	17	6.0	0	0.0
1157	Wisconsin	50-64 Years	Male	447	346	58	3.0	23	4.0
1158	Wisconsin	50-64 Years	Female	225	191	21	0.0	6	1.0
1160	Wisconsin	65 +	Male	264	221	29	1.0	10	3.0
1161	Wisconsin	65 +	Female	149	127	20	0.0	2	0.0

609 rows × 9 columns

Fig. 1. Visual representation of the data after removal of unnecessary columns and empty rows.

Although that may seem like a significant reduction, the redacted rows provided either no information at all or information that was irrelevant to the research question.

Then, we generated box plots for each column as a means of checking for extreme outliers. However, there were outliers present in columns ‘Pancreas’, ‘Heart’, and ‘Lung’ were not removed as they were not due to incorrect input and were still relevant to our research question. The outliers found were more likely due to those particular organs being less commonly requested for transplants compared to organs such as kidneys or liver which are in constant high demand. Then we generated frequency tables for each state included in the dataset. It is important to note that Alaska, Idaho, Montana, and Wyoming were not listed in the dataset.

III. RESULTS

When analyzing our data, we decided against removing outliers because the removal would reduce our data by a significant amount as well as skew the data greatly. In addition to this, the outliers were not due to incorrect input or entry, but rather due to states with fewer overall organ transplant requests, requesting uncommon organ types. This can be seen when comparing box plots and frequency distributions. This can be seen when examining any of the uncommon organ request types. The pancreas for example is not requested at all in multiple states available in our dataset, states with high request rates such as California do not report more than 86 pancreatic transplantation requests. This can be seen in Figure 2.

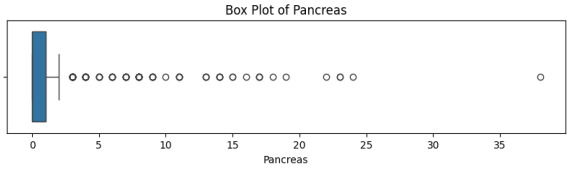

Fig. 2. Boxplot depicting the spread of pancreatic transplant requests in all states available in the dataset.

Through data visualization conducted through frequency tables, there are clear trends in organ type requests. Across all states included in our dataset, the kidney is consistently the most commonly sought-after organ with the liver as runner-up. Despite this, there is a significant difference in need between the two most requested organs. The number of requests for liver transplants rarely ranges above two hundred, while requests for kidney transplants

range into the thousands as seen in states such as California or Illinois. When analyzing age groups, we were able to determine which age groups most commonly appear on the organ donation transplant list. Through examination via boxplots, as shown in Fig. 3, we were able to see that among the age groups available in our dataset, ages 6-65 were contained in the second and third quartiles, while the age group 18-34-year-olds were located at the median.

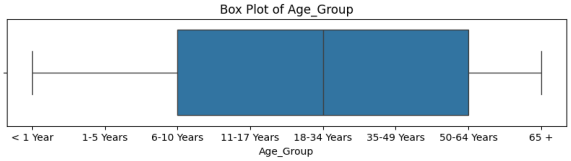

Fig. 3. Boxplot depicting correlations between age group and frequency of transplant requests.

An additional trend observed from our frequency tables indicates that organs such as the pancreas, the heart, and the lung(s) hardly contain more than one hundred requests for transplant each year. These trends are consistent with reports published by the Organ Procurement and Transplantation Network (OPTN). In January 2024, OPTN reported that over 90 percent of living donor transplants are kidney transplants [4]. Through frequency tables depicting the number of women vs. men requesting any sort of organ transplant, we were able to determine that more women are currently on an organ transplant waitlist compared to men.

III. DISCUSSION

We concluded that women tend to be more represented on organ transplant waitlists and that kidney transplants are the most commonly needed organ transplants, followed by liver.

Our study highlights a significant gender disparity on organ transplant waitlists, with women being more represented. This trend could be attributed to factors such as disease prevalence, as autoimmune diseases such as lupus are a leading cause of kidney and liver transplants and women are more likely to develop conditions such as lupus [5]. This necessitates further investigation to develop targeted interventions that address these disparities.

Furthermore, the predominance of kidney transplants as the most commonly needed organ aligns with the high incidence of kidney conditions, such as chronic kidney disease [6]. This highlights the urgency of enhancing kidney health awareness and expanding preventive healthcare measures.

The gender disparity in organ transplant waitlists raises important ethical considerations regarding fairness, justice, and equity in healthcare. It prompts questions about potential biases in the evaluation and selection process for listing patients for transplant, as well as concerns about equitable allocation of scarce donor organs. Healthcare systems must navigate complex ethical dilemmas, balancing considerations of medical urgency and clinical eligibility with principles of fairness and non-discrimination. Developing transparent and evidence-based criteria for organ allocation, free from biases related to gender, race, or socioeconomic status, is crucial to ensuring ethical practices in organ transplantation. Ethical guidelines and oversight mechanisms should be established to monitor and address any disparities or inequities in access to transplantation services.

These findings have critical implications for healthcare policies, particularly in improving the equity and effectiveness of organ transplant systems. Addressing these issues could lead to more nuanced and equitable healthcare strategies that better meet the diverse needs of the population.

However, our study is not without limitations, which must be acknowledged to interpret our findings correctly. Firstly, our analysis relied primarily on existing data, which may have inherent biases in terms of data completeness, accuracy, or representativeness. For instance, the data may not have captured nuanced factors such as patients' socioeconomic backgrounds, cultural beliefs influencing transplant decisions, or specific barriers faced by different demographic groups in accessing transplant

services. Also, we limited our focus in our study and therefore the results and findings may not be generalizable to other contexts with different healthcare policies, cultural norms, or resource allocations.

Based on the findings of this study and the discussions outlined above, several recommendations emerge for future research, policy, and practice. Longitudinal studies tracking changes in organ transplant demographics, including gender disparities, are essential to monitor progress and identify persistent barriers. Collaborative research efforts involving multidisciplinary teams can explore the intersectionality of factors contributing to transplant disparities, such as race, ethnicity, socioeconomic status, and geographic location. Policy initiatives should look to prioritize equity in organ allocation, enhance access to transplantation services for underserved populations, and promote public engagement in organ donation initiatives. Continued advocacy for ethical guidelines, transparency in organ allocation processes, and cultural competence training for healthcare providers remains crucial in advancing equitable and effective organ transplantation systems globally.

In conclusion, our research provides essential insights into the demographics of organ transplant waitlists, which could be pivotal in shaping future healthcare policies and practices aimed at improving organ transplant equity and efficiency.

IV. CONTRIBUTIONS

As a team, we met regularly to discuss the project and complete milestones such as the abstract and the data story. We all wrote the abstract together, dividing it into a few sentences per person. For the data cleaning process, Aarushi removed excess rows or columns and added state labels to the data, while Alexandra and Jiri executed analytical and visualization codes such as the frequency tables and box plots used to determine the frequency of organ transplant requests and detect outliers and their importance. For the final paper, Aarushi wrote the introduction and discussion sections, while Alexandra wrote the results section and parts of the introduction and methodology. Jiri wrote part of the discussion section and revised and edited the entire paper.

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