

Analyzing Healthcare Attacks: Trends and Impacts

CS 732: Data Visualization Assignment-1 Report

Vidhish Trivedi

IMT2021055

IIT - Bangalore

Bangalore, India

Vidhish.Trivedi@iiitb.ac.in

Sai Madhavan G

IMT2021101

IIT - Bangalore

Bangalore, India

g.saimadhavan@iiitb.ac.in

Krutik Patel

IMT2021024

IIT - Bangalore

Bangalore, India

Krutik.Patel@iiitb.ac.in

I. INTRODUCTION

In this document, we have attempted to answer the question "*How to understand the safety of health care infrastructure in conflict-ridden countries*" by performing analysis and exploration on the "Attacks on Health Care in Countries in Conflict (SHCC) Data"[1]. The given dataset has data from 2017 to 2022.

We have broken down our analysis into the following three tasks:

- **T1:** Analyzing Trends and Impacts of Attacks on Healthcare Across the Years
- **T2:** Searching for Insights in Attacks on Healthcare and Profiling Perpetrators
- **T3:** Analysis of Attacks on Healthcare Workers by Country

II. TASKS

A. T1: Analyzing Trends and Impacts of Attacks on Healthcare Across the Years

To understand the trend of these attacks over the years, it is important to visualize the magnitude of the attacks per year for all the years we have data for. We do this by plotting a bar chart (Fig. 1) representing the number of attack incidents for all the years from 2017 to 2022.

We see that the number of attacks shows a trend of increasing over the years in general. The year 2020 seems to be an exception to this trend. We also observe that the year 2022 is an outlier with its significantly higher number of incidents in comparison to the other years.

We next try and understand the number of health workers being affected by these attacks. We aim to do this by visualizing four metrics - number of health workers killed, injured, kidnapped and arrested, across these years. We plot a stacked bar chart (Fig. 2) to visualize this. Please note that the data for the number of arrests was not available for the years 2018 and 2020.

Number of Incidents Per Year

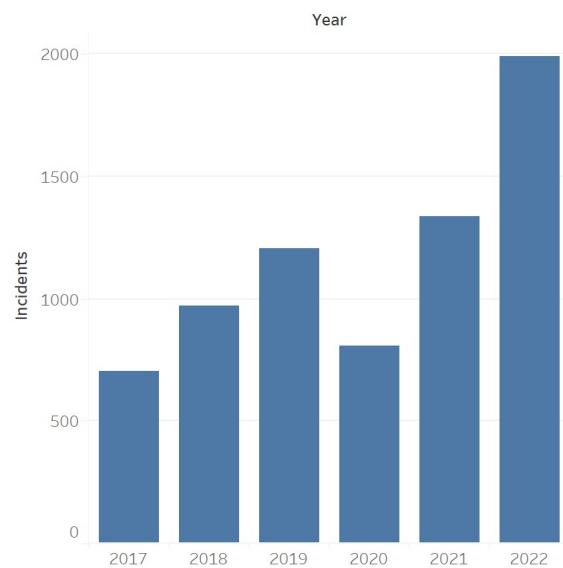


Fig. 1: A stacked bar chart representing the number of attack incidents through the years.

Health Workers Affected Per Year

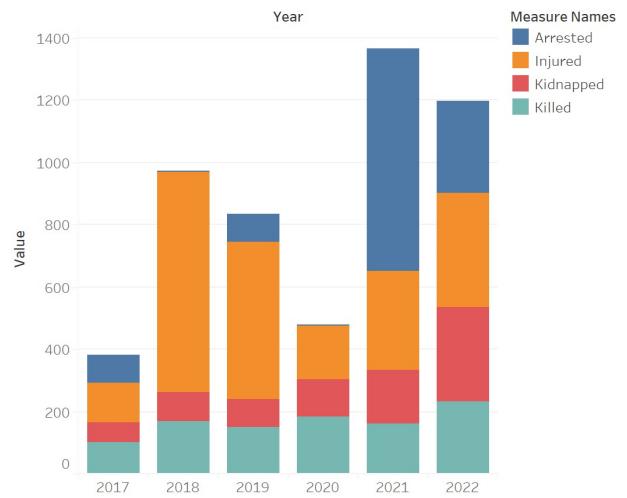


Fig. 2: A bar chart representing the number of health workers affected through the years.

We observe that it is difficult to find a straight-forward correlation between the number of attacks and the number of health workers affected. The absence of data for the number of people arrested for the years 2018 and 2020 makes it all the more challenging. However, we are able to visualize notable outliers such as the number of injuries being high in the years 2018 and 2019, the number of arrests being very high in 2021 and the number of kidnappings being higher than the other years in the year 2022.

Next, we try and understand the trend of the attacks in different countries over the years. We do this by using a colormap to represent the number of incidents per year on a cartographic map with political boundaries of the countries. We then plot this for all the years (Fig. 3a-3f) and look at them sequentially.



Fig. 3a: Number of attacks in the year 2017.

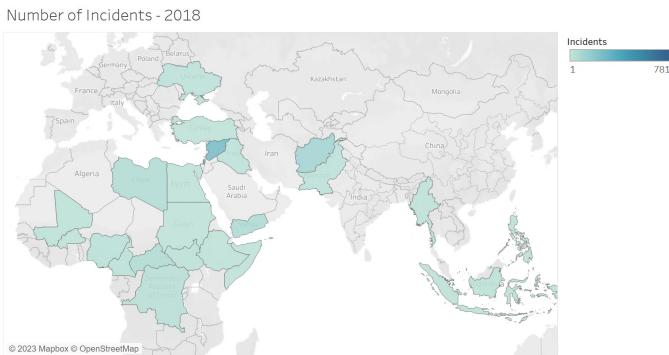


Fig. 3b: Number of attacks in the year 2018.

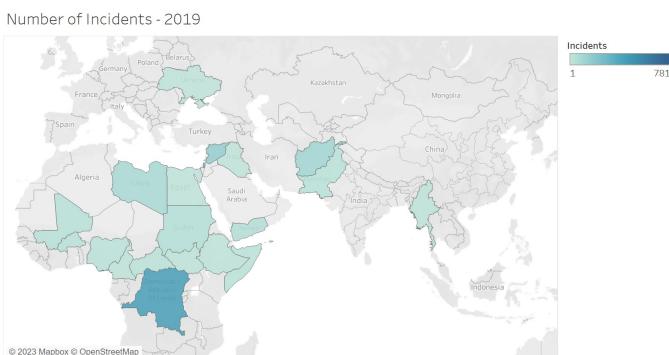


Fig. 3c: Number of attacks in the year 2019.



Fig. 3d: Number of attacks in the year 2020.



Fig. 3e: Number of attacks in the year 2021.



Fig. 3f: Number of attacks in the year 2022.

We see that this series of visualizations gives us some geographic context to the data in hand. We are able to visually observe the impact of the various conflicts in many countries like the conflicts in Syria (in 2018 & 2019), Palestine(in 2018 & 2019), Democratic Republic of Congo (in 2019), Myanmar(in 2021) and Ukraine (in 2022).

In order to understand the cumulative number of incidents across these countries for all the years, we plot an area chart (Fig. 4).

In this visualization, we are able to see conflicts in different countries as clear spikes in the area of the colour they represent. We see how countries like OPT (Palestinian Territories), Syria, DRC (Democratic Republic of Congo), Ukraine, Myanmar and Afghanistan occupy significant areas on the plot. This plot also gives a geographic context to Figure 1, as we can infer that the decline of incidents in 2020 is a consequence the number of incidents in the DRC, Syria

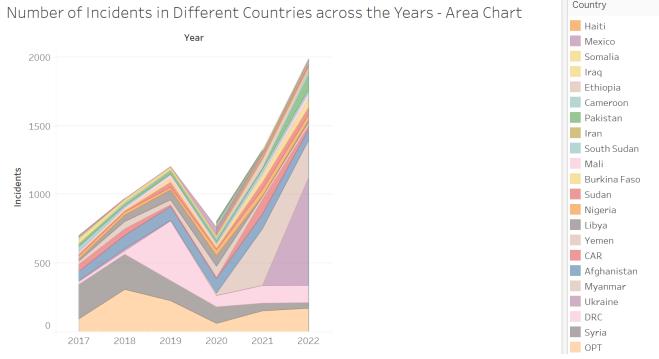


Fig. 4: An area chart representing the number of attack incidents in different countries through the years.

and Palestine decreasing and the Russian invasion of Ukraine being one of the key contributors to the really high number of incidents in 2022.

To get a better understanding of how the number of incidents varied in these countries, we plot a line chart (Fig. 5) of the number of incidents in each country across the years for the top ten countries with the most number of incidents cumulatively. We restrict this plot to the top ten alone as it becomes really difficult to understand the lines if they were more crowded.

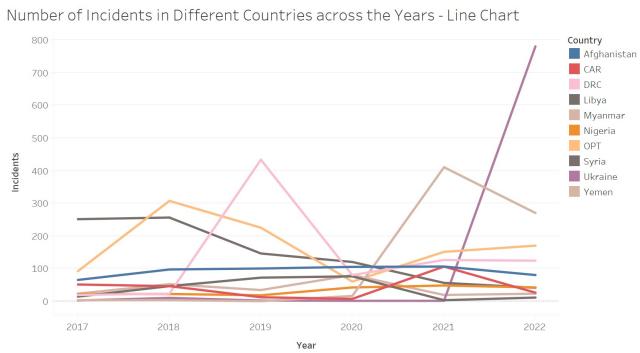


Fig. 5: A line chart representing the number of attack incidents in top ten countries through the years.

From this visualization, we are able to re-affirm the intuitions built by Fig. 3a-f and Fig. 4. The impact of each conflict is also more visually pronounced here as conflict-ridden countries stick out as sharp spikes among the other countries over the period of their conflict.

Now that we have an understanding of how the number of incidents varied over different countries across the years, we try to look at the number of health workers killed, injured, kidnapped and arrested through a geographic lens as well. We use a packed bubble diagram (Fig. 6) to visualize this as the areas give us an intuitive sense of which country had the most number of killings, injuries, kidnappings and arrests without cluttering the diagram too much. We demarcate the years through colour.

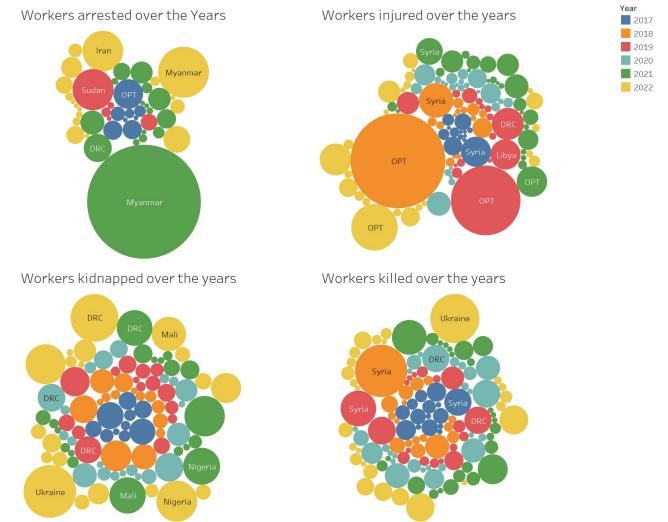


Fig. 6: A packed bubble chart representing the number of health workers affected through the years.

We see that this visualization helps us to make sense of Fig. 2, as now we can observe that the high number of injuries in 2018 and 2019 took place in Palestine and Syria, the high number of arrests in 2021 is a consequence of the military coup that took place in Myanmar. We also see that kidnappings are most prominent in the African countries like DRC (Democratic Republic of Congo), Mali and CAR (Central African Republic).

B. T2: Unmasking Conflict Impact: A Regional Assessment (2020-2022) and Perpetrator Profiling

For this task, we give an overview of *Attacks in Health Care in Countries in Conflict* for the years 2020, 2021, and 2022. We begin by visualizing a high-level view of the entire world, and then zero in on a particular region of conflict. The data stories for 2020, 2021, and 2022 have been attached as PPT files with the submission.

We use these data stories for each year (2020, 2021, 2022) to search for patterns and insights into the given dataset, and then link them to real world events in an attempt to understand the circumstances and reasons behind them.

We will now describe the visualizations for the year 2021 in detail: Year - 2021

From the high-level view of the entire world, it is clear that most of the incidents happened in Myanmar, Occupied Palestinian Territory (OPT), Central Africa Region (CAR) and Dominican Republic of Congo (DRC).

(clockwise) across different months in 2021.

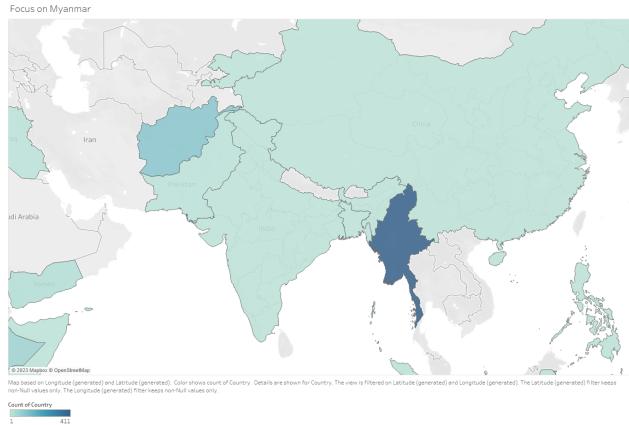


Fig. 7: A zoomed in view, focusing on Myanmar.

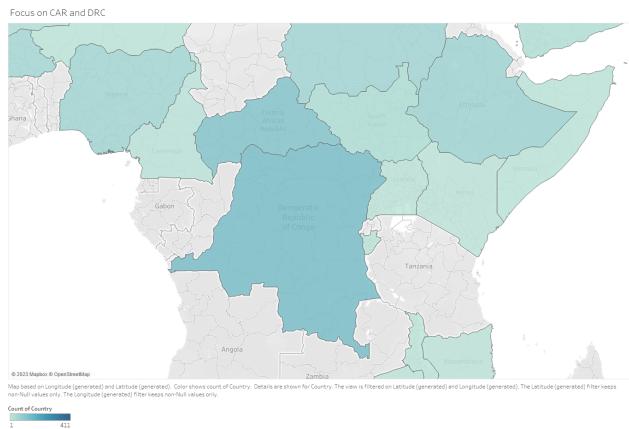


Fig. 8: A zoomed in view, focusing on CAR and DRC.

To investigate and explore this further, we look at the following bar chart, Fig. 9. which confirms our intuition, as a majority of incidents are reported by Myanmar, OPT, DRC and CAR.

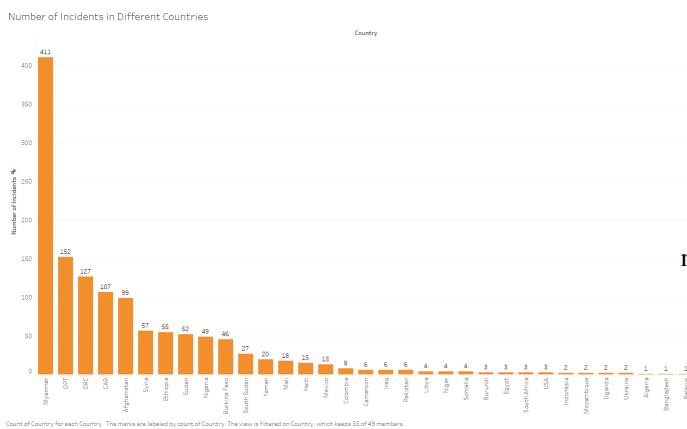


Fig. 9: A bar chart to represent number of incidents in different countries.

We now look at two figures, Fig. 10. is a line chart depicting how the number of incidents reported vary across different months in 2021. Fig. 11. is a comparison of number of the incidents reported in Myanmar, DRC, CAR and OPT

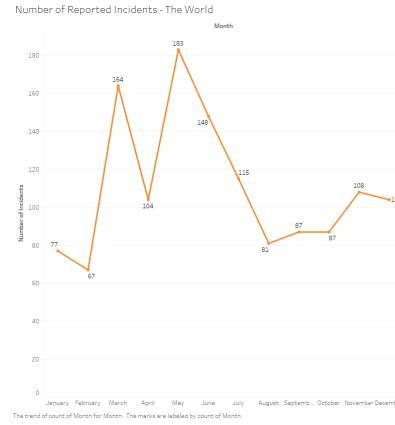


Fig. 10: A line chart to depict variation in number of incidents across months in 2021.

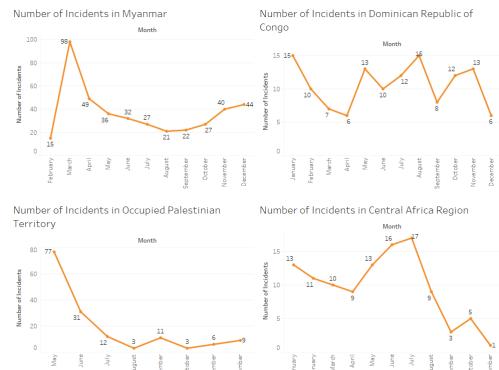


Fig. 11: line charts to compare variation in number of incidents (clockwise - Myanmar, DRC, CAR and OPT) across months in 2021.

These figures provide us with an overview of the trend of number of incidents across different months of the year.

The following bar chart, Fig. 12. depicts which category did the perpetrators of the reported incidents belong to, these can be: State Actor, Opposition Groups, Multiple, and No Information. We can clearly see that this data is dominated by State Actors and Opposition Groups, which can be attributed to the coup in Myanmar in 2021 and to the oppressive regime in Occupied Palestinian Territory.

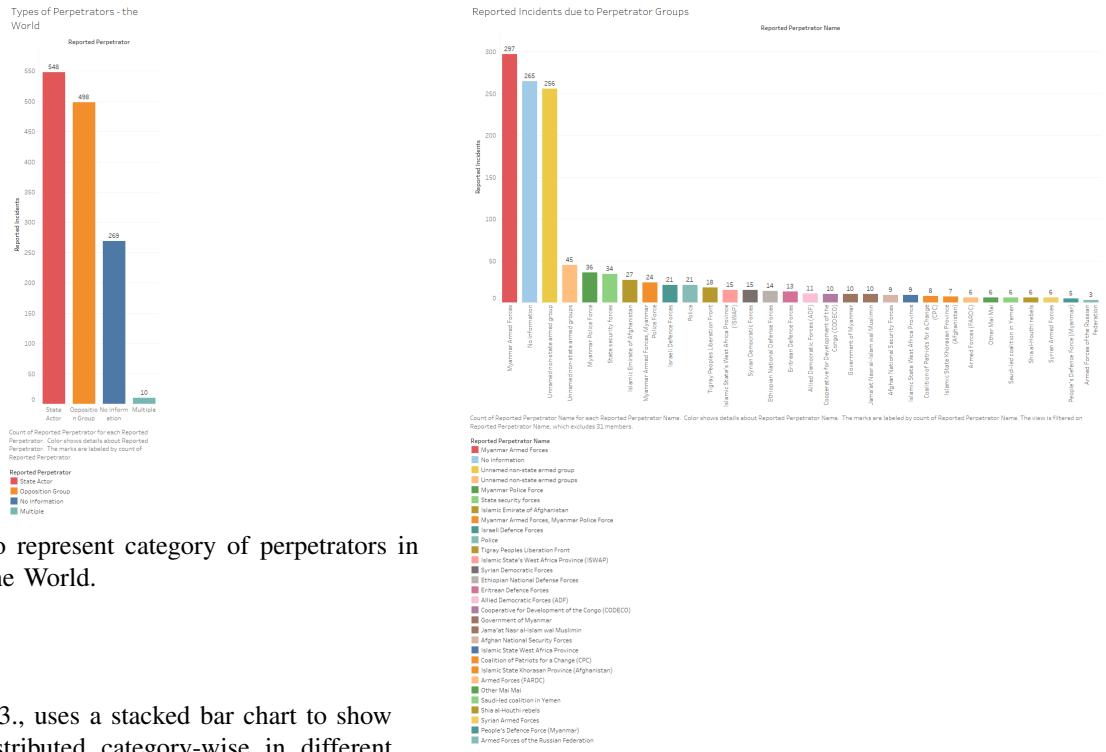


Fig. 12: A bar chart to represent category of perpetrators in reported incidents in the World.

The next figure, Fig. 13., uses a stacked bar chart to show how perpetrators are distributed category-wise in different countries. Each bar represents the distribution of perpetrators in various categories, demarcated by color.

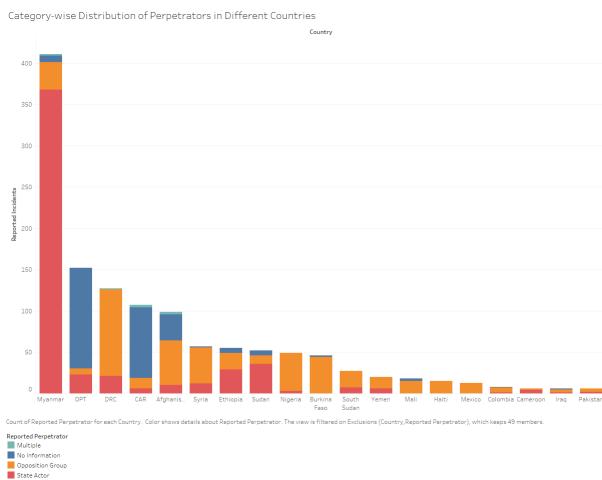


Fig. 13: A stacked bar chart to represent category of perpetrators in reported incidents in different countries.

Figure 14 uses a bar chart to depict the group or organization to which perpetrators belong to. The lack of information is evident here, as can be inferred from the second bar (starting from left).

Fig. 14: Group or organization to which perpetrators belong to.

We again look at two figures, Fig. 15. is a pie chart depicting the distribution of reported incidents among various groups of perpetrators in 2021 for the world. Fig. 16. is a comparison of distribution of reported incidents among various groups of perpetrators in 2021 in Myanmar, DRC, CAR and OPT (clockwise).

Distribution of Incidents by Perpetrator Groups - The World

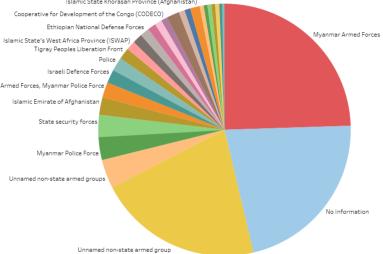


Fig. 15: Group or organization to which perpetrators belong to.

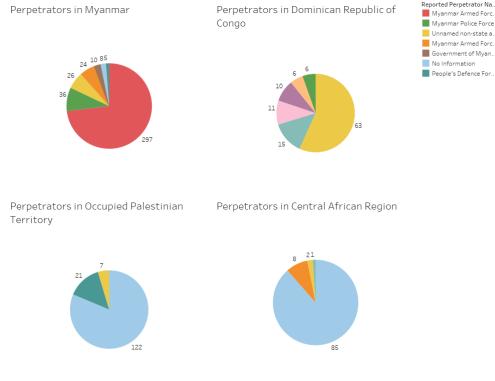


Fig. 16: Group or organization to which perpetrators belong to.

Figure 17 uses a pie chart to show how various weapon types (such as Firearms, Explosives, etc) are used in reported attacks on Health Care in Conflict Countries for the entire world. Again, different colors are used to clearly demarcate the categories.

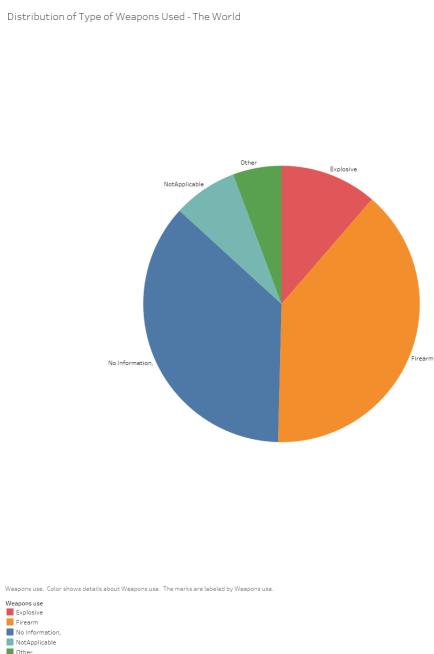


Fig. 17: Weapon types used in reported incidents.

Finally, Fig. 18. depicts how these weapon types are used in reported incidents in different countries. Each country is represented by a stacked bar, and the categories are represented by use of different colors.

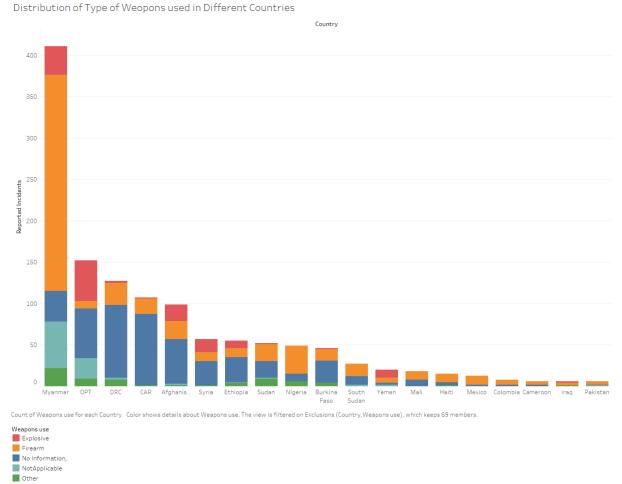


Fig. 18: Weapon types used in reported incidents in different countries.

Note that the data stories for the years 2020 and 2021 follow a similar method of visualizations, they have been attached to the submission for your reference. These include a much more detailed legend for each visualization.

C. T2 - Inferences:

- From the cartographic maps in Fig. 7. and Fig. 8., we identify that in 2021, the regions that reported the most number of attacks on healthcare are Myanmar, Dominican Republic of Congo, Central African Region, and Occupied Palestinian Territory. These beliefs are further confirmed by the bar chart in Fig. 9.
- The line charts in Fig. 10. and Fig. 11. together provide an overview of how the 4 aforementioned regions affect the trend of number of attacks in 2021 (for the entire world) when seen monthly. In Fig. 10., the chart first peaks in March, which can be attributed to the rise in attacks in Myanmar in the same month (March), and then peaks again in May, which can be attributed primarily to the large number of attacks reported in Occupied Palestinian Territory in May. This is evident on comparing Fig. 10. and Fig. 11.
- Figures 12, 14, 15, and 16 in particular indicate that there is a void in information. A large portion of data, especially in regions like Central Africa and Occupied Palestinian Territory, can be attributed to their regime's/government's continuing oppressive and discriminatory system of governing the region. Such regimes often hinder or block the flow of information needed to build dataset such as the one provided.
- The rise of attacks on healthcare in Myanmar in March of 2021 (as seen in Fig. 11., top left) can be attributed to the *2021 Myanmar coup d'état*, which began in February of 2021. [2]
- The rise of attacks on healthcare in Occupied Palestinian Territory in May of 2021 (as seen in Fig. 11., bottom left) can be attributed to the *Escalation of attacks* in

Gaza Strip, West Bank, and East Jerusalem. These led to damage of hospitals, primary health clinics, and other public health infrastructure. [3]

- 6) From the available information, we infer that Firearms and Explosives were the primary categories of weapons used in attacks on healthcare in 2021, and Myanmar was the biggest contributor in terms of reported incidents involving attacks on healthcare (Fig. 17, 18.). This is different than what was observed in the data stories for 2022 and 2020 (attached with the submission), for which the major contributors were war-torn countries like Ukraine, Syria, and Afghanistan.
- 7) From collectively looking at the data stories of 2020, 2021, and 2022, we also observe that the Central African Region (DRC, CAR, Ethiopia, Sudan) have always been in a state of conflict during this period.

D. T3: Analysis of Attacks on Healthcare Workers by Country

The following analysis aims to analyze the attacks on healthcare workers in various countries, focusing on different types of attacks and their impact on healthcare infrastructure. Fig. 19 examines trends in war-torn countries such as Afghanistan, Syria, OPT (Occupied Palestinian Territories), and Myanmar, in 2021, as well as compares them with African nations. The data presented here provides insights into the nature of these attacks and highlights important distinctions between regions.

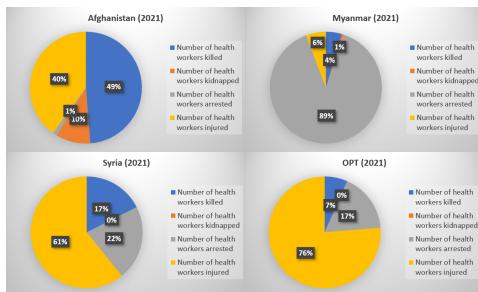


Fig. 19: Pie Charts displaying types of attacks in Afghanistan, Syria, OPT, and Myanmar.

In the war-torn countries of Afghanistan, Syria, and OPT, we observe distinct patterns of attacks on healthcare workers. The pie charts illustrate that in these regions, characterized by political instability or weak governance, there is a higher incidence of injuries and killings, indicating the presence of disorganized perpetrators. In contrast, Myanmar stands out with a significant majority of attacks resulting in arrests, suggesting a more organized state involvement. This aligns with the political upheaval following the coup in early February 2022.

A similar trend can be seen in African nations (Fig. 20), with Afghanistan serving as a comparative reference.

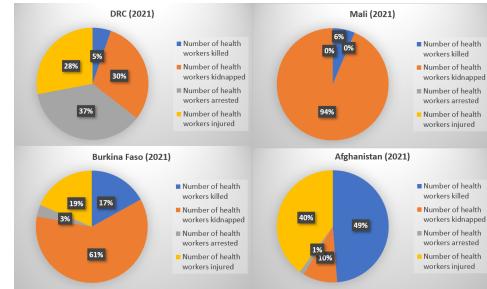


Fig. 20: Pie Chart displaying types of attacks in African nations.

Looking at the pie charts of data from African nations (i.e. DRC, Mali, Burkina Faso), we note a higher occurrence of kidnappings compared to other forms of attack. This implies the involvement of non-state actors, often driven by financial motives such as ransom demands. This trend is consistent with the economic conditions in these less affluent African nations. Also note that the proportion of injuries/killings are lesser in number in African nations, which in contrast to war-torn countries namely Afghanistan, OPT and Syria, which have more than 70% instances of injured/killing combined.

Moving beyond the types of attacks, let us now visualize the repercussions on healthcare infrastructure.

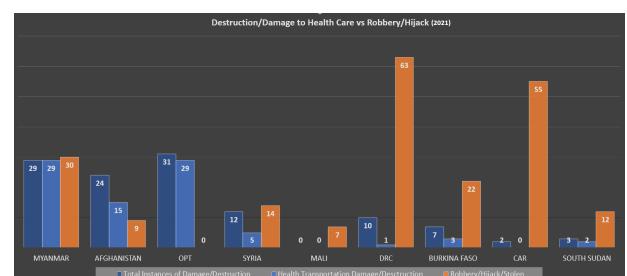


Fig. 21: Bar chart comparing instances of destruction, robbery, and hijacking in various countries.

From Fig 21, it is evident that in countries like Myanmar, Afghanistan, OPT, and Syria, instances of destruction outweigh incidents of robbery or hijacking. This is mainly due to these regions experiencing conflict or civil war in 2021. Conversely, African nations exhibit a higher proportion of robberies and hijackings, with minimal destruction. This fits well with the economic conditions of the populace in African nations.

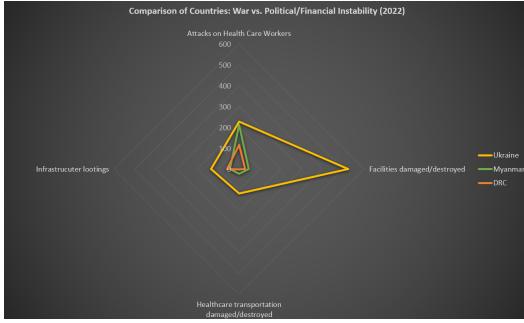


Fig. 22: Comparison of Countries: War vs. Political/Financial Instability (2022)

Comparing the effects of war and political instability on healthcare infrastructure, we observe a notable distinction (Fig 22). War-torn countries (Ukraine) experience a greater degree of damage or annihilation of healthcare facilities, reflecting the intensity of conflict. Conversely, politically/financially unstable countries (DRC and Myanmar) lean towards attacks on healthcare workers, indicating a different dynamic at play. Also the shapes of the radar chart shows that the countries with political/financial unrest (Myanmar, DRC) are more similar, in contrast to Ukraine, which has significantly more health infrastructure destroyed. Noteworthy is the higher ratio of infrastructure looting per facility damaged in DRC, reflecting the economic challenges faced by the nation.

Major Challenges: The biggest challenge was the sheer lack of information available in the dataset. The collection of data was heavily influenced and skewed towards a handful of countries/regions, in which a lot of values were either NULL or indicated that No Information was available. This led to scenarios where the majority category for a variable was itself No Information, making it difficult to arrive at inferences.

III. AUTHORS' CONTRIBUTIONS

Sai Madhavan G: (Task 1: Analyzing Trends and Impacts of Attacks on Health-care Across the Years)

- Conducted data analysis to identify trends in attacks on healthcare facilities.
- Created visualizations, including bar chart, stacked bar chart, cartographic chart, area chart, line chart and packed bubble diagram to represent the data effectively.
- Interpreted the visualizations and drew conclusions about the overall trends in healthcare attacks.
- Wrote the narrative and descriptions for Task 1, providing context and insights.

Vidhish Trivedi: (Task 2: Searching for Insights in Attacks on Healthcare and Profiling Perpetrators)

- Conducted research to understand the motivations and profiles of perpetrators behind healthcare attacks.
- Designed and produced visualizations, including cartographic maps, bar charts, stacked bar charts, line charts and pie charts, to illustrate findings.
- Analyzed the data and identified patterns in the types of attacks and the groups responsible.

- Prepared the narrative and descriptions for Task 2, emphasizing the insights gained into the perpetrators.

Kritik Patel: (Task 3: Analysis of Attacks on Healthcare Workers by Country)

- Collected and processed data related to attacks on healthcare workers in different countries.
- Utilized pie charts, stacked bar charts and radar charts to visualize the geographical aspects of attacks.
- Examined trends and patterns specific to attacks on healthcare workers, including killings, injuries, kidnappings, and arrests.
- Authored the narrative and descriptions for Task 3, highlighting the geographical context of healthcare worker attacks.

Each team member worked independently on their assigned task, including all aspects of data analysis, visualization creation, interpretation, and description. The collaborative effort of all team members contributed to the comprehensive analysis presented in this report.

REFERENCES

- [1] <https://data.humdata.org/dataset/shchealthcare-dataset>
- [2] <https://www.britannica.com/event/2021-Myanmar-coup-d-etat>
- [3] <https://reliefweb.int/report/occupied-palestinian-territory/escalation-occupied-palestinian-territory-issue-2-17-may-2021>