# BLOOD SUPPLY ANALYSIS DURING PANDEMIC IN INDONESIAN RED CROSS OF SEMARANG CITY

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**Abstract.** The coronavirus disease 2019 (COVID-19) pandemic affected healthcare facilities globally. The current condition was a formidable challenge to maintaining blood supply in a blood center. This retrospective cross-sectional study analyzed the impact of COVID-19 Enforcement of Limitation on Community Activities on blood supply management in The Indonesian Red Cross Blood Center in Semarang City. Blood supply management consists of blood collection and receiving blood requests. Our study used secondary data from a blood donor and blood request reports from January to December 2018 and January 2021 to December 2021. Statistical analysis was done by comparing 2018 and 2021 data with an independent t-test. Our findings showed that implementing COVID-19 regulations severely impacted outdoor blood collection in Semarang City. The impact spanned the period of May to August 2021, especially in July 2021 (emergency enforcement of limitation on community activities) when the blood collection decreased by 68% (1,352 units) from the previous month. The amount of in-house blood collection was also found to have been sustained by the regulation impact because of blood recognition events from May until August 2021. The research also found that there was a significant decrease in outdoor blood donors, blood supplies, and blood demand between 2018 and 2021 ($p$<0.05). These findings were due to the amount of outdoor blood collection that was heavily dependent on unforeseen external situations such as a pandemic, a timely mitigation strategy was warranted to sustain blood supply.

**Keywords:** COVID-19, blood center, blood collection, Indonesian red cross, pandemic

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## INTRODUCTION

The Delta variant of coronavirus disease 2019 (COVID-19) caused a significant crisis in Indonesia. Indonesia detected 56,767 new cases on 15 July 2021, with the positive rate increasing to 26% and an average of 919 deaths per day in 1 week (Dyer, 2021). The positive rate caused Indonesia to become the country with the highest confirmed COVID-19 cases and deaths in Southeast Asia. A total of 5 provinces with the highest contribution are DKI Jakarta, West Java, Central Java, East Java, and Yogyakarta. The confirmation case caused the government released Minister for Home Affairs Instruction No. 15/2021 (Ministry of Home Affairs, 2021b) to impose Emergency Restrictions on Community Activities to reduce the incidence and mortality of COVID-19 in Indonesia. Restrictions on individual mobility during the pandemic, such as non-essential business and school activities, prohibition of crowding, and traveling outside the city, significantly reduce confirmed cases of COVID-19 (Prasiska *et al*, 2022; Tenda *et al*, 2021).

The supply chain, especially the Blood Donor Center, is easily affected by uncertain environmental conditions, such as the COVID-19 pandemic, and the supply chain is in crisis conditions. The Restrictions on Community Activities cause uncertainty and complexity in the blood supply chain (Matin *et al*, 2021). Because of these reasons, the Blood Center must have the ability to adapt both during the pandemic and after the pandemic (Bharat *et al*, 2021).

In Korea, blood donors have decreased during the pandemic due to social distancing regulations and outdoor blood donation services (Kwon *et al*, 2021). The study in North China experienced a similar challenge resulting in a significant reduction in blood supply (Wang and Wang, 2022). An insufficient supply of blood products was one reason the hospital postponed the elective surgery (Kwon *et al*, 2021; Wang and Wang, 2022). During the COVID-19

pandemic, the Government of Indonesia changed the transmission control regulations, which have changed the blood supply and demand pattern in both blood centers in the Indonesian Red Cross and hospitals. When the pandemic is under control, it requires primary data to develop a resilience strategy to maintain a blood supply, considering that demand from hospitals will change (Vachhani *et al*, 2022).

Supply chain resilience is the ability to quickly and efficiently repair supply chain disruptions and is essential to restore unit performance to pre-pandemic levels because blood products are products with a short expiration date obtained from volunteers (Matin *et al*, 2021). This resilience process requires learning from many parties and learning from pre-pandemic and pandemic data (Bharat *et al*, 2021). There is no previous study that analyze blood supply and demand in Semarang City during COVID-19 pandemic. Therefore, researchers analyzed the supply management of the COVID-19 pandemic at the Blood Center of the Indonesian Red Cross in Semarang City.

## MATERIALS AND METHODS

This study was a cross-sectional study using secondary data derived from monthly reports of voluntary blood donors and requests for blood products at the Blood Center of the Indonesian Red Cross in Semarang City from January 2018 to December 2018, and from January 2021 to December 2021. This research period was carried out from 1 July 2022, to 31 July 2022. Ethical approval not applicable, because this study did not utilize any data of human subjects. This study has received permission to use the data from the Secretary Committee of the Indonesian Red Cross in Semarang City. This study defined the characteristic of blood donors based on the group of age, gender, and donor location in 2018 and 2021. Characteristics of blood product supply and demand in 2018 and 2021 were analyzed. This study also compared the number of donors from outdoor blood donation drives, inhouse, the number of blood product supply, and blood product demand each month in 2018 and 2021. There were no inclusion and exclusion criteria in this study.

Data analysis was carried out by Statistical Package for Social Science (SPSS) version 25 (International Business Machines Corporation, Armonk, NY). The number of blood products, demand, supply, and donors inside the blood center and outdoor blood donation drives were tested for data normality. When the data distribution was normal and the variance was the same, an unpaired t-test analysis was carried out for the same variance. If the data were distributed normally and have unequal variance, then an unpaired t-test analysis was carried out for different variants. A Mann-Whitney analysis was conducted when the data distribution was not normal. In the research, the *p*-value <0.05 indicated a statistically significant difference (Barton and Peat, 2014).

## RESULTS

The characteristics of donor data at the Blood Center of The Indonesian Red Cross in Semarang City between 2018 and 2021 are described in Table 1

Data for donors in 2018 and 2021 for the 25-44-year age group, and male sex had the most significant proportion when compared to other groups. Outdoor blood donation drives dominated donor sites in 2018, but the proportion changed in 2021. The decline between 2018 and 2021 occurred across all age groups, except for the 45-59 years and ≥ 60 years age group. In the gender segment, the blood donors declined for the male gender between 2018 and 2021, while for the location segment, the decline was noted for outdoor blood donation.

Table 2 shows that the stock of blood products in the Blood Center of Indonesian Red Cross at Semarang City in 2021 has decreased as compared to 2018; the same trend as the demand. In Table 3, when comparing the blood donor from blood product supply and demand in 2018 and 2021, it was found that there were statistically differences in the number of donors in blood product supply and blood demand. However, in Table 4, when comparing the numbers of in-house donors and outdoor blood donation drive in 2018 and 2021, there was no statistically difference in that of in-house donors but a statistically difference in that of outdoor blood donors.

Table 1
Personal protective equipment used by electronic waste collectors

| Characteristic of blood donors | Year | | Compared 2021 to 2018 (Difference in percent) |
|---|---|---|---|
| | 2018 N = 75,388 | 2021 N= 61,131 | |
| Age in years, *n* (%) | | | |
| <18 | 1,477 (1.96) | 460 (0.75) | 66.80% decreased |
| 18-24 | 19,628 (26.04) | 13,093 (21.41) | 33.30 % decreased |
| 25-44 | 37,639 (49.93) | 30,785 (50.36) | 18.20% decreased |
| 45-59 | 16,525 (21.92) | 16,580 (21.12) | 0.30% increased |
| ≥60 | 119 (0.16) | 213 (6.36) | 8.99% increased |
| Gender, *n* (%) | | | |
| Male | 58,868 (78.09) | 43,692 (71.40) | 25.77% decreased |
| Female | 16,520 (21.91) | 17,439 (28.60) | 5.56% increased |
| Donor location, *n* (%) | | | |
| Outdoor | 43,797 (58.10) | 25,925 (42.41) | 40.80% decreased |
| In-house | 31,591 (41.90) | 35,206 (57.59) | 11.40% increased |

Fig 1 shows the impact of the COVID-19 regulation in the City of Semarang on donor visits at the outdoor blood donation drive and inhouse. Outdoor blood donation drive before the pandemic was favorable to donors in Semarang City. Unfortunately, during the 2021 pandemic, all agencies limited their access to outdoor blood donation drive. As a result, in-house donors in 2021 have dominated. The most significant difference occurred when emergency enforcement of limitations on community activities was implemented. Outdoor blood donations are usually conducted in institutions with the participation of internal agency officials or the general public. When emergency restrictions on community activities were enforced, institutions such as education and the non-essential sector conducted 100% work-from-home activities, making outdoor blood donation activities impossible. Essential and critical sectors implemented policies requiring 25-50% of staff

Table 2
Characteristic of blood product supply and demand in Blood Center of Indonesian Red Cross at Semarang City

| Blood product | Blood supply (bag) | | | Blood demand (bag) | | |
|---|---|---|---|---|---|---|
| | 2018 | 2021 | Difference (%) | 2018 | 2021 | Difference (%) |
| Whole blood | 9,079 | 3,518 | 61.20% decreased | 3,291 | 2,098 | 36.25% decreased |
| Packed red blood cell (PRBC) | 63,697 | 54,036 | 15.16% decreased | 43,783 | 38,893 | 11.16% decreased |
| Leukodepleted PRBC | 5,283 | 5,535 | 4.77% increased | 5,669 | 5,900 | 4.07% increased |
| Leukoreduced PRBC | 613 | 575 | 6.19% decreased | 613 | 445 | 27.40% decreased |
| PRBC pediatric | 291 | 721 | 147.00% increased | 291 | 741 | 154.00% increased |
| Platelet concentrate (PC) | 47,754 | 30,153 | 36.85% decreased | 31,567 | 25,159 | 20.30% decreased |
| PC apheresis | 1,031 | 571 | 44.60% decreased | 1,032 | 570 | 44.70% decreased |
| PC pooling | 1,652 | 312 | 81.10% decreased | 1,652 | 312 | 81.10% decreased |
| Fresh frozen plasma | 13,146 | 2,905 | 77.90% decreased | 3,203 | 1,481 | 53.70% decreased |
| Anti-hemophilic factor | 588 | 436 | 25.85% decreased | 429 | 378 | 11.8% decreased |
| Washed red cell | 17 | 18 | 5.80% increased | 17 | 18 | 5.80% increased |
| Convalescent plasma | 0 | 5,261 | 5,261.00% increased | 0 | 4,263 | 4,263.00% increased |
| Total all blood product | 143,151 | 104,041 | 27.32% decreased | 91,547 | 80,258 | 12.33% decreased |

Table 3
Comparison of blood donor from blood product supply and demand in 2018 and 2021

| Blood management | Year | Number of months | Mean ± SD | Mean difference (95% CI) | *p*-value* |
|---|---|---|---|---|---|
| Blood supply† | 2018 | 12 | 11929.25 ± 1115.18 | -3260.67 (-4107.67, -2413.66) | <0.001 |
| | 2021 | 12 | 8668.58 ± 870.64 | | |
| Blood demand‡ | 2018 | 12 | 7628.91 ± 720.36 | -940.75 (-1654.81, -226.68) | 0.012 |
| | 2021 | 12 | 6688.16 ± 950.63 | | |

*Unpaired t-test with the same variance; †Blood supply was made from outdoor blood donation drive and inhouse blood donors; ‡Blood demand was from other healthcare blood request

CI: confidence interval; SD: standard deviation

Table 4
Comparison of in-house donors and outdoor blood donation drive in 2018 and 2021

| Donor location | Year | Number of months | Mean ± SD | Mean difference (95% CI) | *p*-value* |
|---|---|---|---|---|---|
| Outdoor blood donation drive | 2018 | 12 | 3649.75 ± 844.97 | -1489.33 (-2155.36, -823.31) | <0.001* |
| | 2021 | 12 | 2160.41 ± 723.65 | | |
| In-house | 2018 | 12 | 2632.58 ± 725.74 | 417.25 (-73.42, 907.91) | 0.090† |
| | 2021 | 12 | 3049.83 ± 335.91 | | |

*Unpaired t-test with the same variance; †Unpaired t-test with different variance

CI: confidence interval; SD: standard deviation

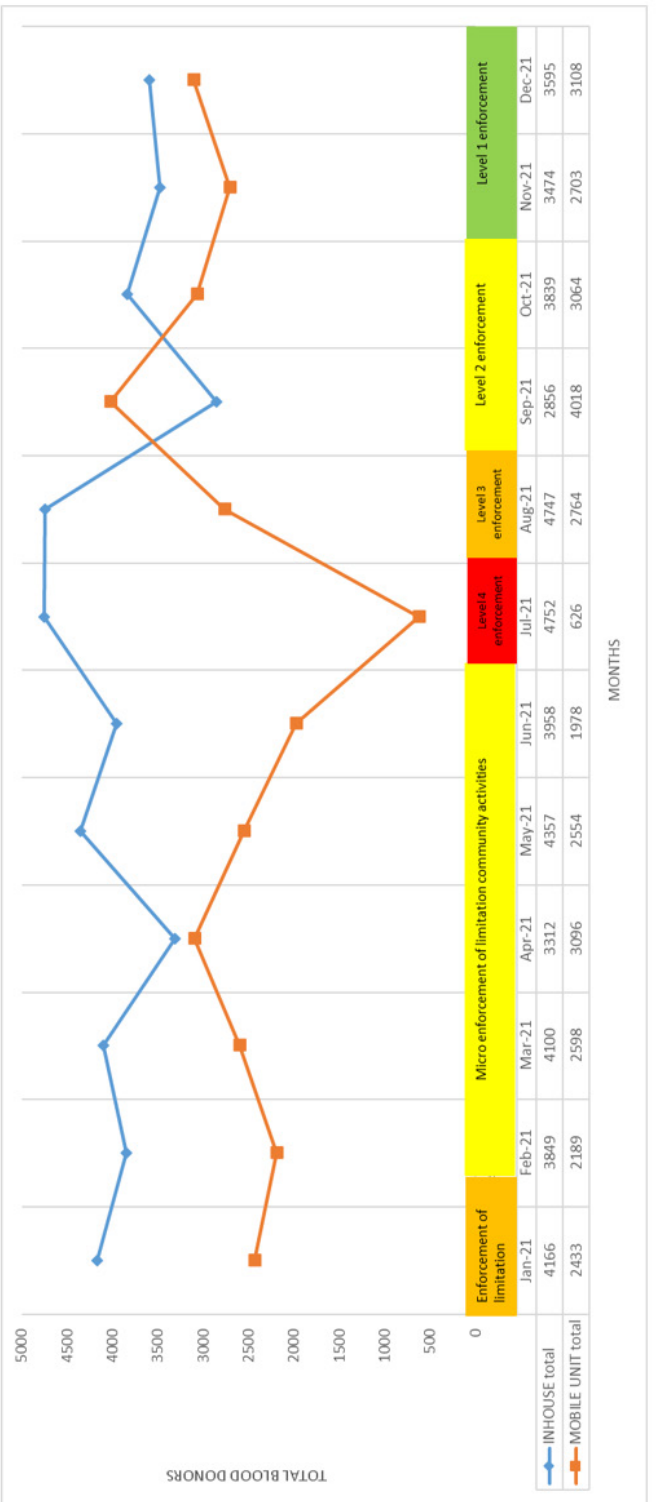


Fig 1 - Comparison of in-house blood donors with outdoor blood donation drives/ mobile unit in 2021

to work from their offices and strictly enforced health protocols for visitors. There were fewer donors, staff struggled to organize events, and people could not spend much time in those institutions as a result of this condition. In spite of the change in enforcement status, each institution has the policy to organize blood drives based on employees' capabilities and strict health protocols for visitors.

## DISCUSSION

COVID-19 Delta variant caused the government to decide on the policy of imposing restrictions on social activities on 7 January 2021, under Home Ministerial Instruction No.1/2021 (Ministry of Home Affairs, 2021a). On 5 February 2021, Home Ministerial Instruction No. 17/2021 implemented micro-enforcement of limitations on community activities which regulates up to the village level (Ministry of Home Affairs, 2021c). On 1 July 2021, the enforcement of the limitation on community activities was in effect until 2 August 2021 in Java and Bali. The government then eased activity restrictions in Levels 3, 2 and 1 enforcement of community activity limitations in December 2021 (Mahendradhata *et al*, 2021).

This research found that regulating restrictions on community activities were affected by the characteristics of donors and preferences for blood donor locations. Male donors were found to continually dominate in 2018 and 2021 despite a decline. The findings were similar to the studies in Nigeria and Greece (Gkirtsou *et al*, 2022; Ogar *et al*, 2021), where men were dominating the voluntary donor population. By comparison, female donors were more likely to fail as donors because they tend to avoid blood donation during menstruation (Gkirtsou *et al*, 2022; Ogar *et al*, 2021). In relation to age group, this study also found that the group of 25-44 years-old were also dominating as donors in 2018 and 2021. This finding was in line with a prior study by Gkirtsou *et al* (2022), where donors' age was within the average of 37.8±11.2 years. Intention to be a regular blood donor was significantly related to attitudes, knowledge related to blood donation, and older age. (Gkirtsou *et al*, 2022).

The characteristic donor uplift in our study, such as female gender and

older age group, we hypothesized was also due to blood donation campaign activities during the pandemic. However, as we used secondary data and limited sample size, the hypotheses for the female gender and older age group were inconclusive and needed further research on those segments.

Outdoor blood donation drives were found to have dominated the preference for donor sites in 2018, but the proportions changed and were statistically significant in 2021 ($p$<0.001). This finding was in line with a prior study by Vachhani *et al* (2022), where the number of donors of outdoor blood donation drives before the lockdown period was dominant compared to in-house donors, and in-house donors became dominant during a lockdown. We hypothesized that the main contributor to the blood donor decline in 2021 is the enforcement of regulation of limitations on community activities during the COVID-19 pandemic.

This study also found that there was a significant decrease in blood supply ($p$<0.001) and blood demand ($p$=0.012) between 2018 and 2021. The most significant blood product supply decline was contributed by platelet concentration pooling, followed by fresh frozen plasma and whole blood. The decline in blood supply also occurred globally due to concerns about donating for fear of contracting the virus. The desire to donate was reduced during the pandemic and called to limit outdoor activities (Hakami *et al*, 2022). Similar findings occurred in Makassar City, Indonesia (Putra *et al*, 2021). The decrease in demand for blood from hospitals was due to the postponement of elective surgery during the pandemic to minimize the spread of the COVID-19 virus in hospitals. Transfusion requests at the hospital focus on emergency cases such as trauma, postpartum hemorrhage, severe anemia, and emergency surgery (Putra *et al*, 2021). This significant decline in demand had a major impact, especially on demand for blood products such as platelet concentration pooling, platelet concentration apheresis, and fresh frozen plasma. This decline was partly due to the Semarang City referral center hospital which has been producing blood products independently since the 2020 pandemic and thus decreased demand from other hospitals. This decrease also occurred in Saudi Arabia with packed red blood cells (PRBC), fresh frozen plasma (FFP), and platelet concentration (PC) products of 14, 11 and 1.6 percent, respectively (Hakami *et al*, 2022). In contrast, blood products

such as convalescent plasma and pediatric PRBC have increased in Semarang City. The increase for pediatric PRBC was because there were socialization efforts from the Blood Center of Indonesian Red Cross to pediatricians since 2018, so the demand was increasing.

The implementation of the COVID-19 policy affected outdoor blood collection in Semarang City. The decline in the number of donors began to be seen in May 2021, with the lowest point in July 2021. Since the limitation on community activities in January 2021, all agencies have closed the implementation of blood donation in their work areas. During the emergency enforcement of limitations on community activities, the public was advised not to go outside even though the outdoor blood donation drive was operating as usual, so the blood collection has decreased by 68% (1,352 units) from the previous month. The number of mobile unit donors, however, had increased again since Level 3 enforcement of limitation on community activities came into effect and even jumped to Level 2 enforcement, this jump was due to the limitation on community activities that were implemented because several agencies began to open access to donate blood in their institutions as usual.

However, there was a decline again from October to December 2021. The blood centers have succeeded in maintaining the number of in-house blood donations to meet the blood demand in the hospital by holding routine blood recognition every month depending on the current blood supply and demand. The blood centers were found to have held a social media campaign and routine blood recognition program from May 2021 with ten events, June with five events, July with nine, and August with ten events.

Even though there have been efforts to increase the blood donor number, the proportion between in-house donors was still dominant and has not returned to the pre-pandemic condition. The researcher suggests digitizing the registration of blood donors and blood requests both with mobile application (volunteers) and websites (hospital staff) by optimizing *'Sahabat UDD Save Life'*. This digitization has been carried out by various countries, one of which is Saudi Arabia, under the name of Wateen (Alessa, 2022). The evaluation results of the Wateen application showed that it was practical and acceptable to donors and health workers because it increased

awareness to donate, increased the efficiency of the donation process, and facilitate the needs of donors and health workers (Alessa, 2022).

The suggestion of using the latest technology, 'Biosmart and Safe Bus' for blood donor vehicles were found significant (Asri *et al*, 2021). It was found that volunteers often used blood donation vehicles such as cabin buses to make donations outside the room. As a solution to make the number of mobile unit donors not affected by the pandemic regulatory conditions, the 'Biosmart and Safe Bus' program can be used. 'Biosmart and Safe Bus' was initiated by Awal Prasetyo to prevent the risk of exposure to airborne infectious particles or pollutants (Asri *et al*, 2021). Its cabins combined high-efficiency particulate air (HEPA) filter and ultraviolet-C (UV-C) lamp technology and was coated with nanosilver to maintain temperature and humidity to reduce the vehicle virus transmission rate (Asri *et al*, 2021).

Another suggestion was to visit an outdoor blood donation partner to re-open blood donation events in their institution. Finally, blood donor campaigns through social media were warranted to anticipate changes in blood demand that would have resumed services such as elective surgery and transfusion (Miah, 2022).

In conclusion, outdoor blood collection capabilities are heavily dependent on unforeseen external factors. In this case, the external factors were COVID-19 regulation changes that limited outdoor activities in 2021. The external factors had impacted outdoor blood collection in Semarang City. The research found a significant decrease in outdoor blood donors, blood supplies, and blood demand between the years 2018 and 2021. The brief suggestion of this study such as consideration of using the latest technology, 'Biosmart and Safe Bus' as blood donor vehicle, visit an outdoor blood donation partner to re-open blood donation events and blood donor campaigns through various social media.

## ACKNOWLEDGMENTS

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## CONFLICT OF INTEREST DISCLOSURE

The author reports no conflicts of interest in this work.

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