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The Use of Seasonality Data Analysis for Decision-making for Improved Maternal Health in Rwanda, 2025

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ABSTRACT

INTRODUCTION: Rwanda's high coverage of facility-based deliveries and strong routine health information systems provide a unique opportunity to examine seasonal patterns in maternal and newborn health service utilization and translate these findings into actionable health system planning.

METHODS: National routine data on health facility deliveries, Bacillus Calmette–Guérin (BCG) vaccination, and first antenatal care visits ("new registrations") were extracted from the Health Management Information System (DHIS2) for financial years 2012/13–2024/25. Monthly totals were aggregated at the national level and analysed descriptively using visual inspection of trends and calculation of five- and ten-year monthly averages to identify recurring seasonal patterns.

RESULTS: Clear and consistent seasonality was observed in health facility deliveries and BCG vaccination across the thirteen-year period. Deliveries were substantially lower than the monthly average in January (–2,354 deliveries) and markedly higher in May (+2,866 deliveries), with BCG vaccination closely mirroring this pattern. In contrast, first antenatal care visits demonstrated a different seasonal distribution, with higher-than-average registrations in January and lower attendance between July and September, indicating misalignment between early antenatal attendance and subsequent peak delivery periods.

CONCLUSION: The findings support targeted, low-cost interventions, including the strategic scheduling of maternity staff leave and training, adjustments to supply-chain ordering practices, refinements of data quality outlier detection tools, and intensified sensitization for early antenatal care during optimal periods. Routine seasonality analysis should be integrated into evidence-based planning to strengthen maternal and newborn health outcomes.

INTRODUCTION

Seasonality of malaria and other vector-borne diseases, as well as conditions linked to nutrition, is well documented [1,2]. Seasonality of maternal and child health indicators is less well researched. Maternal and child mortality are key indicators used to track progress in improving maternal and child health towards the global health targets, such as the Sustainable Development Goals (SDG),

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particularly SDG 3 [3]. To meet these targets, evidence-based interventions that are context-specific are required. Correct interpretation of available data is an important starting point [4].

Rwanda is a landlocked country in Central/East Africa with a population of 14.1 million [5]. Rwanda has made significant improvements in maternal and child health in the past twenty years. The Rwanda Demographic Health Surveys show a steep decline in both maternal and child mortality [6]. However, ambitious national targets, as outlined in the Health Sector Strategic Plan (2024/25-2028/9) [6], aim to reduce maternal mortality to 60 per 100,000 live births and under-five child mortality to 20 per 1,000 live births by the end of 2029 [7].

The Demographic Health Surveys are conducted every five years in Rwanda [8]. Meanwhile, routine data is collected from health facilities. The platform used since 2012 to manage routine health data is DHIS2. This data system enables the analysis of trends in key indicators, which have been tracked for the past thirteen years. Measures are taken to improve data quality, both formally in Data Quality Reviews and informally through communication between the Monitoring and Evaluation Units and those entering data into the system at the peripheral level. The World Health Organisation (WHO) Data Quality Tool has been uploaded onto the DHIS2 platform and is used by data managers to monitor for data entry errors.

The objective of this study was to provide evidence-based recommendations to improve maternal outcomes in Rwanda. The specific objective was to determine the seasonality patterns of delivery, BCG vaccine, and prenatal services in Rwanda from financial years 2012/13 to 2024/25, from which to base the recommendations.

METHODS

Study Design and Setting

The study was conducted in Rwanda due to the good quality of routine data [9] and high health facility delivery rates [10].

Data Source

The data source was the Rwanda Health Management Information System. The data elements selected for the study were Health facility deliveries, BCG vaccination, and New Registrations. These data elements received good quality performance review scores in recent years, i.e., less than a five percent discrepancy between register entries and Health Management Information System (HMIS) reports. Health facility delivery and BCG national rates are over 95% [10]. BCG vaccinations are given at birth, before the mother and baby are discharged from the hospital after delivery. This implies a close link between BCG vaccination and health facility delivery. The indicator *"New Registration*" refers to the first antenatal visit a woman attends during her pregnancy.

Data Collection Tools and Procedures

Data for each indicator were downloaded from the District Health Information System 2 (DHIS2) into Excel for the financial years 2012/13 -2024/25. The DHIS2 is the platform used in Rwanda to collect and store health data for the Health Management Information System. The total number for each service (antenatal care, deliveries, and BCG vaccination) for each month from 2012/13 to 2024/25 was downloaded from DHIS2. The total number of services provided nationally for this entire period is included.

Data Analysis

The data was aggregated at the national level for each financial year. The financial year in Rwanda begins on July 1st and ends on June 30th. Microsoft Excel was used to create a separate worksheet for each indicator. Data was inserted in the relevant column for the month and year. Line graphs were generated, with one line representing each year, to support the interpretation of the results. The analysis was by visual inspection. Both five and ten-year average monthly values were calculated per indicator.

Ethical Considerations

This study used secondary data from the Health Management Information System. This data does not have any individual patient details. The study was conducted as a routine evaluation by the officers responsible for data management and interpretation.

RESULTS

The trends in each of the three indicators, Health Facility Deliveries, BCG vaccination, and New Registrations, are presented in two graphs, one from 2012/13-2018/19 and the other from 2019/20-

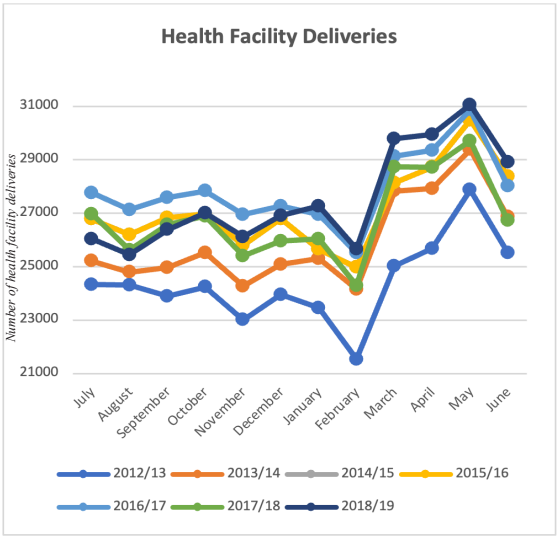

Figure 1: *Number of health facility deliveries FY2012/13-FY2018/19 (Source: HMIS)*

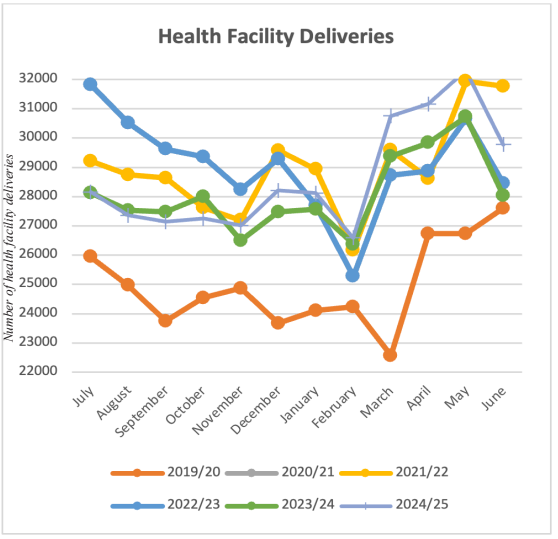

Figure 2: *Number of health facility deliveries FY2019/20-FY 2024/265 (Source: HMIS)*

2024/25. The graphs combining all ten years were found to be too congested.

Health Facility Deliveries

The monthly average number of health facility deliveries over the thirteen years was 27,357. In February, there were an average of only 25,003 deliveries during the same time period, 2,354 fewer deliveries than expected. In May, there were an average of 30,223 deliveries from FY 2012/13 to 2024/25. This is 2,866 more deliveries than expected. The pattern was consistent for both February and May compared to other months throughout the thirteen years. The trend is shown in Figures 1 and 2.

As expected, the seasonality pattern of BCG vaccination was similar to that of Health Facility Deliveries, since babies are vaccinated before they and their mothers are discharged post-delivery. Babies who do not live long enough to be vaccinated and multiple pregnancies (twins, triplets, etc.) are not taken into account in this study. Figures 3 and 4 show the same trends as health facility deliveries.

Antenatal Care Visits

The antenatal care visits are presented by the data

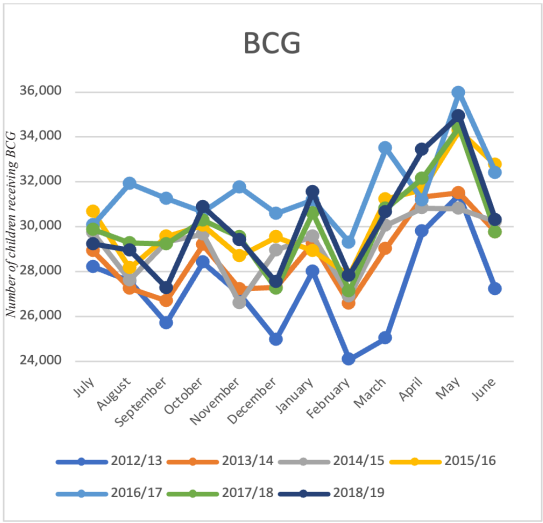

Figure 3: *Number of children receiving BCG vaccine FY2012/13-FY2018/19 (Source: HMIS)*

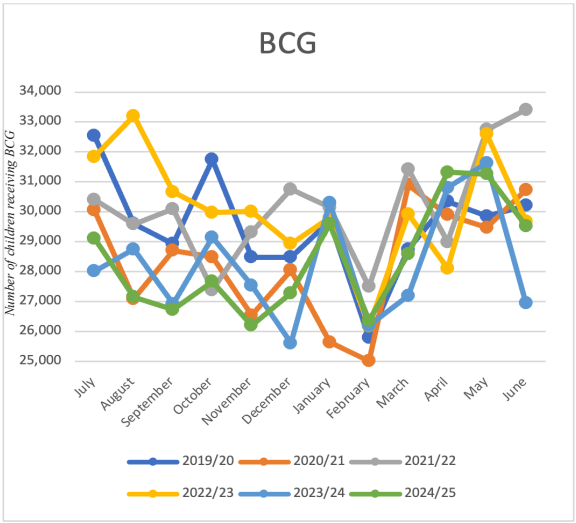

Figure 4: *Number of children receiving BCG vaccine FY 2019/20-2024/25 (Source: HMIS)*

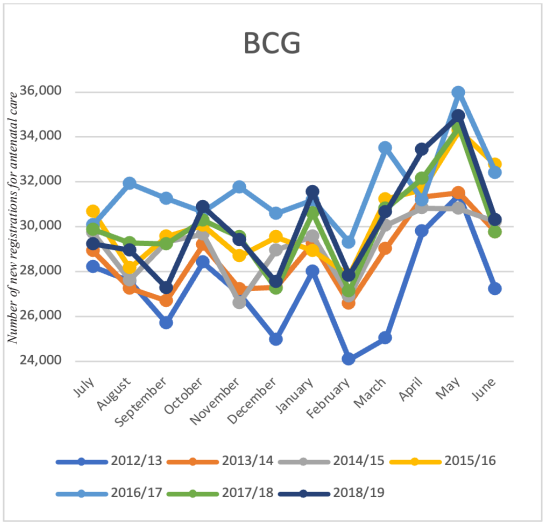

Figure 5: *Number of new registrations for antenatal care FY2012/13-FY2018/19 (Source: HMIS)*

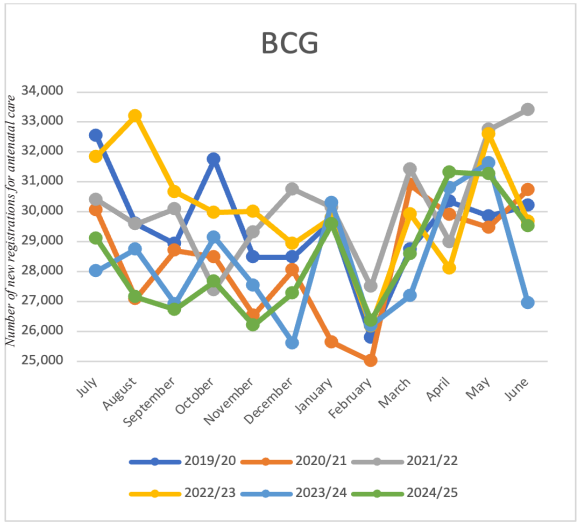

Figure 6: *Number of new registrations for antenatal care FY2019/20-FY2024/25 (Source: HMIS)*

element New Registrations. The average number of New Registrations over the thirteen years was 31,547. A seasonal pattern was observed. There was a high prenatal registration in January, with 5,143, above the monthly average for the time period. Lower-than-average registrations were found in July, August, and September (1,854, 1,632, and 1,678, respectively, below the monthly average for FY2012/13-2024/25). This seasonal trend does not follow the same pattern as deliveries, if first antenatal visit was in the first trimester of pregnancy as recommended by the WHO. Figures 5 and 6 show the seasonality trends for antenatal care for FY2012/13 to FY2024/25

DISCUSSION

The results of the seasonality analysis clearly showed seasonal trends in health facility deliveries in Rwanda. As expected, the number of newborns vaccinated for BCG follows the same seasonal patterns. However, a higher first antenatal visit would be expected in September to November, aligning with the seasonality pattern of deliveries. This is not observed in the data from 2012/13 to 2024/25. The consequences of these seasonality patterns for health system management and the introduction of interventions are discussed in this section.

The first consequence is related to health workers in maternity units. Health Centres and hospitals in Rwanda have a fixed number of staff per cadre recommended for each type of health facility. Not all those positions are filled. Staff contracts provide for one month of leave per year. In addition to annual leave, staff may be granted days off for sickness and personal reasons, such as attending funerals. In addition to these absences, Non-Governmental and International Organisations offer off-site training to staff. The facilitators for these trainings are often drawn from the senior obstetricians and midwives working on the wards of hospitals. The Ministry of Health also invites senior obstetricians and other maternity staff to workshops, meetings, and training sessions. The results from this study suggest that permission for staff leave and training/meetings from maternity units in health centres and hospitals should be scheduled to avoid the high workload months of April to June, in favour of January and February.

In Rwanda, almost a quarter of deliveries are conducted by Caesarean Section [10]. These are performed in the District, Referral, and Teaching Hospitals, as well as a few selected health centers. Over half of maternal deaths in Rwanda occur post-cesarean section [10]. The need to consider the timing of leave and trainings/meetings for staff involved in Caesarean sections during peak delivery months is, therefore, even more crucial. In addition, the results suggest that non-urgent major surgeries should be planned outside the peak delivery months, particularly in May, to reserve the operating theatres for Caesarean Sections whenever possible.

Another consequence relates to the supply chain. Systems recommended for ordering supplies are

typically based on the consumption of medicines and supplies for the previous three months. The Logistics Management Information System "can generate a summary report and a requisition order with suggested replenishment quantities" [10]. If these recommendations are followed to order supplies for the maternity units from April to June, i.e., using the consumption of the months January to March, shortages of essential medicines and supplies are likely to occur.

Another health system that will be affected by the seasonality of Mother and Child Health Indicators is the monitoring of data quality. The World Health Organization data quality tool contains a system to monitor data outliers. In this context, data outliers are entries in the Health Management Information System that are two standard deviations (2SD) from the other entries. For example, if a health centre reports around 50 deliveries each month, with a range of 45-55 deliveries, but for one month, 75 was entered, the data outlier tool will highlight the number 75. The expectation is that the data manager of that health facility will follow up by checking the data source, usually the health facility registers. All data managers have been trained on the use of this data quality tool. However, the increase in the number of deliveries in May is often more than 2 standard deviations (SD) above the norm. The tool, therefore, requires adjustment to the seasonality patterns.

One of the key findings of the study is related to the first antenatal visit. This service is recommended to take place before the 12th week of pregnancy. In Rwanda, only half of women present for this vital service within the recommended timeframe. Since more babies are delivered in May, more first antenatal visits would be expected to be between October and December. During one week in November each year, Rwanda conducts an intensive campaign to provide maternal and child health services, known as Mother Child Health Week. This would be an ideal time to promote early presentation to a health facility for newly pregnant women. More women in early pregnancy would be reached in the Mother Child Health Weeks conducted in November than in the ones organised in March/April.

The authors recognize that there are limitations to the study. The focus was on the management of health systems to adapt to the seasonality of childbirth. The reasons behind the patterns that emerged were not investigated. However, for deliveries, the months of high conception fall in the dry season, during which many marriages take place. Further research is proposed to explore the factors contributing to the seasonality of deliveries and the first prenatal visit in Rwanda. The study did not include the data element of home deliveries. This was because the proportion of home deliveries of total deliveries is low. Exclusion of home deliveries did not affect the results of the seasonality analysis in health facilities, nor did it impact the conclusions; however, a further analysis of seasonality in home deliveries is recommended. Finally, the analysis of the data element BCG vaccination did not account for stillbirths, babies who did not survive long enough to receive the BCG vaccination nor multiple pregnancies (such as twins or triplets). In these circumstances, the delivery would have taken place, but the corresponding BCG vaccine would not have been administered, or two vaccinations would have been given in the case of multiple pregnancies. Although this did not affect the conclusion nor recommendations drawn from the study, a thorough analysis of the link between BCG vaccination and health facility delivery is also recommended.

CONCLUSION

Seasonality of deliveries is marked in Rwanda and has an impact on several health systems as described above. The following recommendations are proposed: 1. To relieve the high burden of deliveries in May, training and leave for maternity staff and non-urgent major surgeries should be avoided in the months when most deliveries occur, particularly in District Hospitals. 2. Medicines and supplies should be ordered to take into account the seasonality, i.e. the three-month historical consumption does not apply. 3. The data quality outlier tool in the DHIS2 should be adapted to take the seasonality of deliveries into account. 4. To increase the proportion of antenatal first visits within the first 12 weeks of pregnancy sensitisation and mobile clinics should be provided during the Mother and Child Health weeks in November.

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