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Analysis Prevalence and Effectiveness of the Stunting Management Intervention Program for Toddlers in Bogor City

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ABSTRACT

Stunting remains a major public health challenge in Indonesia. Although various intervention programs have been implemented, more effective strategies are needed to achieve the targeted reduction in prevalence. Based on the findings of this study, the City of Bogor reduced its stunting prevalence from 3.32% in 2022 to 2.35% in 2024. This study aimed to identify the key factors contributing to the success of stunting intervention programs using a Root Cause Analysis (RCA) approach, focusing on program implementation at the sub-district level. The methods included Exploratory Data Analysis (EDA) to examine spatial-temporal trends in stunting prevalence and RCA based on secondary data, program documents, and interpretation of EDA findings. Potential causes affecting program performance were categorized using a fishbone (Ishikawa) framework. The results showed that the decline in stunting prevalence was accompanied by an increase in child weighing coverage from 88.83% to 99.49% and a reduction in disparities across sub-districts. RCA identified six key factors influencing program effectiveness: (1) the number and competence of Posyandu cadres relative to community awareness; (2) standardization of procedures and cross-sectoral coordination; (3) availability of anthropometric measurement equipment; (4) targeted distribution of supplementary feeding (PMT) and vitamins; (5) family participation and nutritional literacy; and (6) data accuracy and timely follow-up of cases. These factors were derived from program documents, secondary data interpretation, and fishbone-based categorization. The findings provide evidence-based recommendations for sustaining stunting reduction through more targeted interventions.

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INTRODUCTION

The issue of stunting among children under five remains a concern that requires cross-sectoral intervention to ensure optimal child growth and development (Indriana, 2024). Stunting cannot be considered a trivial problem, as it affects not only height but also the overall quality of life and future of the child. Stunting occurs due to chronic malnutrition, particularly during the first 1,000 days of life, which begins from pregnancy until the child reaches two years of age (Haskas, 2020). During this critical period, inadequate nutritional intake can hinder brain development and other body tissues, thereby increasing the risk of impaired cognitive function, low immunity, and susceptibility to degenerative diseases in adulthood (Sari et al., 2025).

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The classification of stunting refers to the measurement of a child's height or length compared to the WHO growth standards, where a child is categorized as stunted if they fall below -2 standard deviations (SD) from the median growth standard. This classification applies to children under five years old, particularly during the critical first 1,000 days of life (Hilmy & Fatharani, 2021). In addition to serving as a diagnostic tool, stunting classification is also important for determining appropriate interventions and monitoring the effectiveness of public health programs. According to Azizah (2023), stunting is divided into two categories: Stunted (mild to moderate), with a height-for-age z-score (HAZ) between -2 SD and -3 SD, and Severely Stunted (severe), with a HAZ below -3 SD, indicating serious growth impairment that requires intensive intervention (Azizah, 2023).

The problem of stunting is complex and multidimensional. Its causes are not limited to the availability of nutritious food but also include parental knowledge, environmental sanitation, parenting practices, and the socio-economic conditions of families. Low-income families often face difficulties in meeting the daily nutritional needs of their children (Irawan et al., 2023). In addition, various myths regarding complementary feeding practices still circulate in society, such as the belief that fish consumption causes intestinal worms or restrictions on certain vegetables for unclear reasons. In fact, a complete nutritional intake is essential to support optimal child growth (Ahnafani et al., 2024).

The impact of stunting is also long-term. Children who experience stunting tend to have lower cognitive abilities compared to those with adequate nutrition and are at a higher risk of developing chronic diseases such as diabetes and hypertension in adulthood (Samsuddin et al., 2023). If the prevalence of stunting is high in a region, it will undoubtedly affect overall regional development.

At the national level, the prevalence of stunting has decreased from 37% in 2007 to 24.4% in 2021. However, the government's target to reduce stunting to 14% by 2024 requires an average annual reduction of 3.5% (Tarmizi, 2023). This target is not easy to achieve, especially following the COVID-19 pandemic, which disrupted various basic health services, including child nutrition monitoring. In the City of Bogor, stunting prevalence decreased from 18.7% in 2022 to 18.2% at the end of 2023 (Nugraha & Nuryasin, 2024). This decline indicates improvement; however, in terms of the rate of reduction, it is still far from the national target.

In principle, various efforts to address stunting have been implemented in the City of Bogor through nutrition education programs, monitoring of child growth and development, and campaigns on the importance of fulfilling nutritional needs during the first 1,000 days of life (Latifa, 2018). Nevertheless, challenges remain in the field, such as the limited number of healthcare workers covering all areas and suboptimal cross-sectoral coordination. As a result, program implementation has often not been fully effective.

Despite the availability of routine stunting surveillance data, the utilization of data analytics to support decision-making remains relatively limited. Most stunting studies focus on nutritional and public health aspects, while studies employing data-driven approaches to identify spatial-temporal patterns, regional disparities, and trends in stunting prevalence remain relatively scarce. Exploratory Data Analysis (EDA), as an important stage in data science, enables researchers to identify patterns, trends, relationships among variables, and anomalies within datasets through statistical exploration and data visualization techniques (Ningrum & Ismawardi, 2025; Oettl et al., 2024). The availability of stunting data across sub-districts in the City of Bogor provides an opportunity to apply EDA and visual analytics to support monitoring, evaluation, and evidence-based policymaking.

To complement the data exploration process, Root Cause Analysis (RCA) can be used to systematically identify the underlying factors influencing program outcomes. RCA is a problem-solving method that helps identify the root causes of a problem through a cause-and-effect approach (Michael A. Irawan & Farida Pulansar, 2024).

Therefore, this study integrates Exploratory Data Analysis (EDA) and Root Cause Analysis (RCA) to analyze patterns of stunting prevalence and identify the key factors affecting the effectiveness of stunting intervention programs in the City of Bogor. The findings are expected to support the development of evidence-based policy recommendations, strengthen program monitoring and evaluation systems, and contribute to more targeted and sustainable stunting reduction strategies.

RESEARCH METHOD

Research Stage

This study employs a quantitative approach with an exploratory descriptive study design, integrating Exploratory Data Analysis (EDA) and Root Cause Analysis (RCA) methods. This combined approach represents the novelty (state of the art) of this research, as it has not been widely applied simultaneously in the context of regional-level stunting analysis. Based on the literature review, previous studies have generally applied EDA to explore stunting trend data or RCA to qualitatively examine causal factors. In this study, EDA is used to extract patterns, trends, and anomalies from stunting data in the City of Bogor for the period 2022–2024, while RCA is conducted to identify root causes based on EDA findings in a more in-depth and systematic manner.

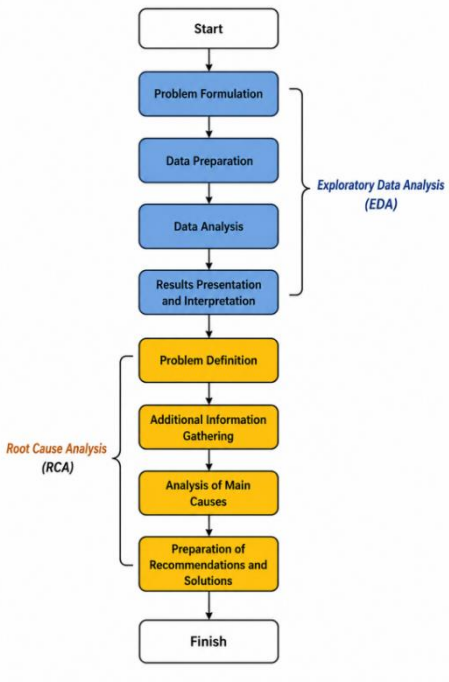

Figure 1. Flowchart

All data analysis processes in this study were conducted digitally and in an automated manner using Google Colab, a cloud-based computing platform, with the Python programming language. EDA Phase are Problem Formulationm, Data Preparation, Data Analysis, Results Presentation and Interpretation and RCA Phase are Problem Definition, Additional Information Collection, Root Cause Analysis, Recommendation and Solution Development. The secondary data obtained, in the form of .xlsx files from the Child Weighing Month (BPB) and documents related to the stunting reduction acceleration program, were processed using various Python libraries such as Pandas for data manipulation, Matplotlib and Seaborn for visualization, and NumPy and Scikit-learn for statistical analysis and further exploration. The data cleaning process was carried out systematically to ensure completeness, consistency, and uniform formatting before proceeding to the exploration and visualization stages.

With this research design, the results are expected to provide an in-depth overview of stunting patterns in the City of Bogor while identifying the main inhibiting factors in its management. This integrated EDA & RCA approach, supported by information technology, is also expected to serve as a new methodological alternative (state of the art) in the field of Information Systems, which can be replicated in other regions with similar issues, thereby producing more targeted and evidence-based policy solutions.

Data Processing Stages

After the research data were obtained, the next step was to process the data systematically to ensure that the analysis could be conducted more effectively. The initial stage involved data inspection and cleaning (data cleaning). The data obtained from the Health Office of the City of Bogor were first examined to ensure completeness, proper formatting, and consistency across years and sub-districts. Some of the data were still in the form of Excel tables with non-uniform structures, requiring adjustments such as removing empty rows, selecting relevant variables, standardizing column names, and merging data from multiple sheets or files.

After the data cleaning process was completed, the dataset used for analysis consisted of five variables: year, sub-district, child weighing coverage (%), stunting prevalence (%), and the number of stunting cases. The year variable covered the observation period from 2022 to 2024, while the sub-district variable represented the administrative sub-districts within the City of Bogor, the data were converted from Excel format (.xls or .xlsx) into .csv (Comma-Separated Values) format to facilitate processing using the Python programming language through the pandas library in Google Colab (Irsan et al., 2024).

The prepared data were then grouped by year and sub-district for the calculation of the required indicators. Two main indicators were calculated: Bulan Penimbangan Balita (BPB) coverage and stunting prevalence. The coverage indicator was calculated by comparing the number of children weighed to the target population, while stunting prevalence was calculated by comparing the number of stunting cases to the number of children weighed (Damayanti et al., 2021). These calculations were processed directly in Python, and the results were stored in new variables to facilitate further analysis.

```
df['Coverage'] = df['Ditimbang'] / df['Sasaran'] * 100
df['Prevalensi Stunting'] = df['Kasus Stunting'] / df['Ditimbang'] * 100

df
```

	Tahun	Kecamatan	Kelurahan	Sasaran	Ditimbang	Kasus Stunting	Coverage	Prevalensi Stunting
0	2022	Bogor Selatan	Ranggamekar	1237	1193	50	96.443007	4.191115
1	2022	Bogor Selatan	Batutulis	690	610	14	88.405797	2.295082
2	2022	Bogor Selatan	Genteng	695	767	7	110.359712	0.912647
3	2022	Bogor Selatan	Kertamaya	545	712	4	130.642202	0.561798
4	2022	Bogor Selatan	Rancamaya	627	738	9	117.703349	1.219512
...	...	...	...	...	...	...	...	...
199	2024	Tanah Sareal	Kayumanis	1092	1092	26	100.000000	2.380952
200	2024	Tanah Sareal	Kencana	1956	1955	40	99.948875	2.046036
201	2024	Tanah Sareal	Sukaresmi	1013	1013	10	100.000000	0.987167
202	2024	Tanah Sareal	Sukadamai	1121	1120	12	99.910794	1.071429
203	2024	Tanah Sareal	Mekarwangi	1776	1776	30	100.000000	1.689189

204 rows × 8 columns

Figure 2. Calculation of Coverage and Stunting Prevalence

After calculating the indicators of weighing coverage and stunting prevalence, the next step was data aggregation. The aggregation process was performed using the groupby() function in the pandas library, which groups the data based on the Year and Sub-district variables. Subsequently, summation (sum) was applied to the Target, Weighed, and Stunting Cases variables, while the average (mean) was calculated for the Coverage and Stunting Prevalence variables.

```
df = df.groupby(['Tahun', 'Kecamatan']).agg({
    'Sasaran': 'sum',
    'Ditimbang': 'sum',
    'Kasus Stunting': 'sum',
    'Coverage': 'mean',
    'Prevalensi Stunting': 'mean'}).reset_index()

df = df[['Tahun', 'Kecamatan', 'Coverage', 'Prevalensi Stunting', 'Kasus Stunting']]

df
```

Figure 3. Descriptive Analysis Using Statistical Functions

Next, the data were visualized in graphical form to present clearer patterns. The visualizations included trend graphs of stunting cases per year, comparisons across sub-districts, distribution of prevalence, and the relationship between child weighing coverage and stunting prevalence. These visualizations were intended to support data exploration visually, making the discussion easier to understand.

After obtaining the results of the analysis and visualization, the next step was to identify the factors causing disparities in stunting in the City of Bogor using Root Cause Analysis (RCA). RCA is an analytical method that helps identify the main causes of a problem with the aim of preventing its recurrence in the future. In its application, a Fishbone Diagram or Cause and Effect Diagram was used, which categorizes the causes of problems into six main categories: man, machine, method, material, measurement, and environment (Rhomadhon & Trimintarsih, 2025). Through this approach, problems can be examined systematically so that relevant solutions can be designed. The analysis process using the fishbone diagram was carried out through four main steps: identifying the problem, determining the key factors involved, identifying possible causes, and conducting an in-depth analysis of the resulting diagram.

RESULTS AND DISCUSSION

The data that have undergone cleaning and structural adjustment include variables such as year, sub-district name, child weighing coverage (%), and stunting prevalence (%). Weighing coverage indicates the proportion of children under five who were weighed relative to the target population, while stunting prevalence represents the percentage of stunted children among the total number of children weighed.

After the data cleaning process was completed, the dataset used for analysis consisted of five variables: year, sub-district, child weighing coverage (%), stunting prevalence (%), and the number of stunting cases. The year variable covered the observation period from 2022 to 2024, while the sub-district variable represented the administrative sub-districts within the City of Bogor. Child weighing coverage (%) was used to measure the proportion of toddlers who were weighed relative to the target population, stunting prevalence (%) represented the proportion of stunted children among those measured, and the number of stunting cases indicated the total identified cases of stunting in each sub-district.

Overview of Stunting Cases in the City of Bogor

The absolute number of stunting cases among children under five in the City of Bogor has continued to decline, from 2,363 cases in 2022 to 1,849 cases in 2023, and further down to 1,588 cases in 2024. This represents an absolute reduction of 775 cases, equivalent to approximately 32.8% over the 2022–2024 period. In line with this trend, the average stunting prevalence also showed a consistent decrease, from 3.32% in 2022 to 2.67% in 2023 and 2.35% in 2024, as illustrated in the following graph.

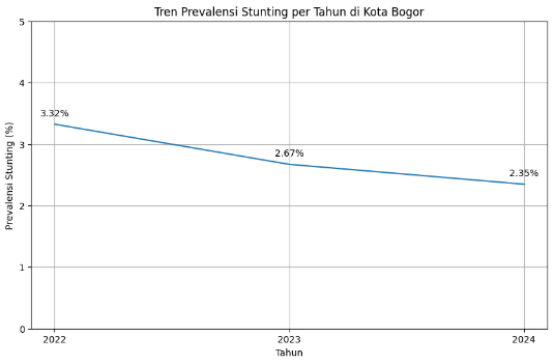

Figure 4. Stunting Prevalence in the City of Bogor by Year

These findings indicate an improving trend, although they do not by themselves establish a causal effect of the intervention program.

a. Number of Stunting Cases by Sub-district
The distribution of stunting cases across the six sub-districts of the City of Bogor from 2022 to 2024 shows a general downward trend.

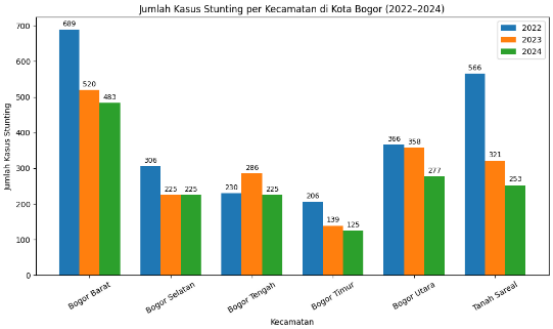

Figure 5. Number of Stunting Cases by Sub-district in Bogor City, 2022–2024

West Bogor consistently recorded the highest number of cases, although it decreased from 689 (2022) to 483 cases (2024). Tanah Sareal showed a significant decline from 566 to 253 cases, while North Bogor decreased from 366 to 277 cases. Central Bogor experienced an increase in 2023, followed by a decline in 2024. South Bogor and East Bogor recorded the lowest numbers in 2024, with 225 and 125 cases, respectively. These

results indicate gradual improvement across all regions.

b. Proportion of Stunting Cases by Sub-district
The analysis of the proportion of stunting cases by sub-district provides an overview of each region's contribution to the total number of stunting cases in the City of Bogor in 2024.

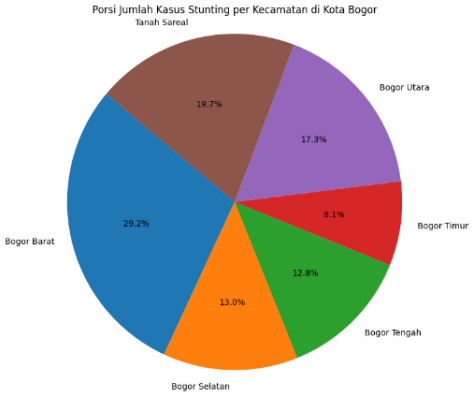

Figure 6. Proportion of Stunting Cases by Sub-district in 2024

In 2024, West Bogor contributed 29.2% of the total cases, followed by Tanah Sareal (19.7%) and North Bogor (17.3%). East Bogor had the smallest proportion at 8.1%. This composition highlights West Bogor as a priority area for intervention to significantly reduce its contribution to stunting cases.

Analysis of Stunting Prevalence

a. Comparison of Average Stunting Prevalence by Sub-district
The average stunting prevalence across sub-districts during the 2022–2024 period shows significant disparities. Central Bogor (4.08%) and West Bogor (3.89%) recorded the highest rates, while South Bogor (1.70%) and East Bogor (2.04%) had the lowest. Tanah Sareal (2.51%) and North Bogor (2.45%) were in the middle range.

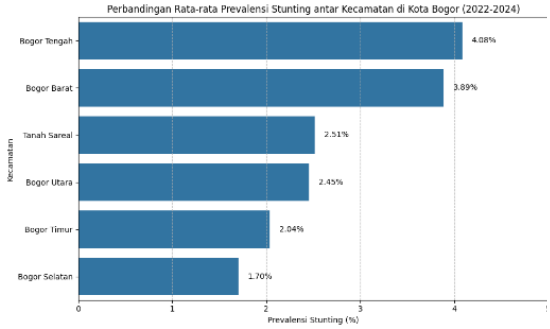

Figure 7. Comparison of Average Stunting Prevalence Across Sub-districts

This highlights the need for special attention to sub-districts with higher prevalence so that interventions can be more evenly distributed.

b. Distribution of Stunting Prevalence by Sub-district
The annual distribution shows that Central Bogor consistently recorded the highest prevalence, particularly in 2023 (4.7%), while West Bogor, which initially had the highest rate in 2022 (5.0%), experienced a significant decline in the following year. In contrast, South Bogor, East Bogor, and Tanah Sareal showed lower rates with a stable downward trend. Meanwhile, North Bogor tended to fluctuate but remained relatively stable within the range of 2%–2.7%.

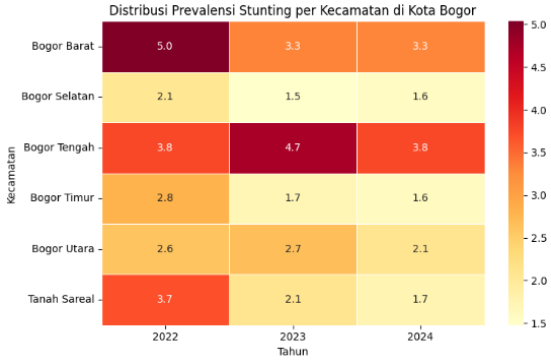

Figure 8. Distribution of Stunting Prevalence by Sub-district

This variation highlights the existence of disparities across regions that need to be addressed through more targeted interventions tailored to local conditions.

Analysis of Child Weighing Coverage

a. Trend of Child Weighing Coverage by Year
The analysis of child weighing coverage trends is necessary to assess the extent to which efforts to monitor child growth in the City of Bogor have reached the target population each year.

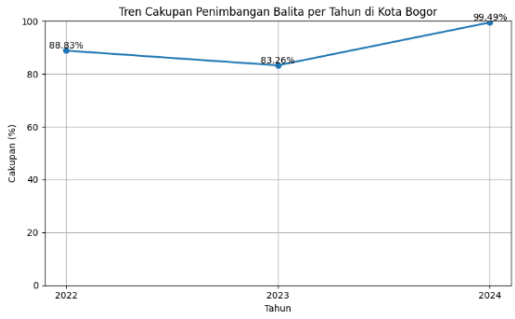

Figure 9. Trend of Child Weighing by Year

Child weighing coverage is an important indicator for assessing the reach of growth

monitoring efforts. During 2022–2024, coverage in the City of Bogor fluctuated: 88.83% (2022), decreased to 83.26% (2023), and then increased sharply to 99.49% (2024). The significant increase in 2024 indicates improvements in program implementation and more optimal community participation, thereby supporting more representative prevalence data.

b. Comparison of Average Weighing Coverage Across Sub-districts

In addition to observing annual trends, comparing the average coverage across sub-districts is important to map areas with optimal monitoring service coverage as well as those that are still lagging behind

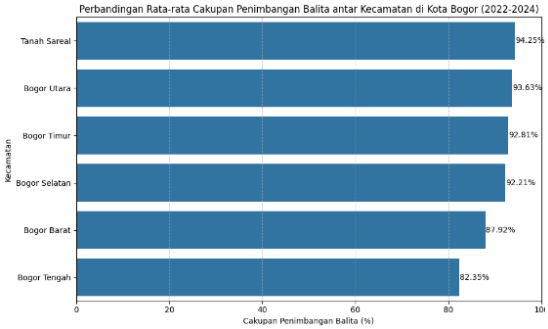

Figure 10. Stunting Cases by Sub-district in 2024

The analysis of average coverage by sub-district reveals that Tanah Sareal (94.25%), North Bogor (93.63%), East Bogor (92.81%), and South Bogor (92.21%) have the highest coverage. In contrast, West Bogor (87.92%) and Central Bogor (82.35%) are relatively lower. Areas with lower coverage risk affecting data accuracy and program effectiveness, thus requiring greater attention in resource distribution and technical assistance.

c. Distribution of Child Weighing Coverage by Sub-district

The analysis of the distribution of weighing coverage by sub-district provides a more detailed overview of fluctuations and disparities in achievements across each region. This distribution pattern serves as a basis for evaluation to ensure that all children under five are monitored evenly across all sub-districts.

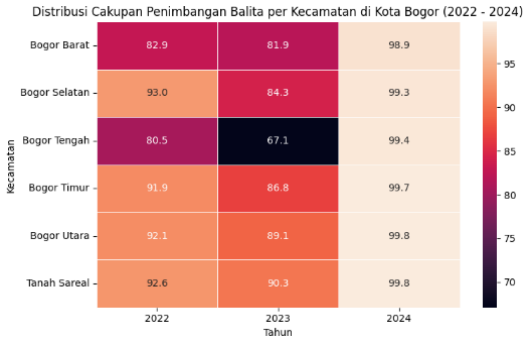

Figure 11. Distribution of Child Weighing Coverage by Sub-district (2022–2024)

The yearly distribution shows that Central Bogor recorded the lowest coverage in 2023 (67.1%) before rising sharply to 99.4% in 2024. West Bogor experienced a similar pattern, with coverage increasing substantially in the final year. In contrast, Tanah Sareal, North Bogor, and East Bogor consistently recorded relatively high coverage levels, particularly in 2024. These variations indicate differences in the performance of child growth monitoring activities across sub-districts during the study period. The substantial increase in coverage observed in 2024 suggests improvements in program implementation and reporting completeness. This pattern highlights the importance of continuous monitoring and evaluation to ensure that high coverage levels can be achieved and maintained consistently across all sub-districts in the City of Bogor.

Analysis of the Relationship of Weighing Coverage

This analysis aims to assess the relationship between the coverage of child growth monitoring services and the success of stunting reduction in each sub-district.

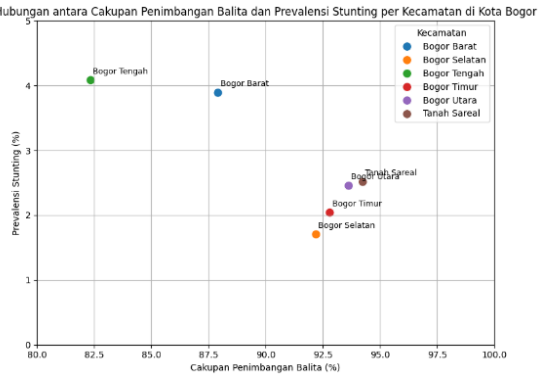

Figure 12. Relationship of Child Weighing Coverage by Sub-district.

Based on the graph, a pattern can be observed in which higher weighing coverage tends to be associated with lower stunting prevalence. However, this trend is not entirely consistent. For example, Central Bogor and West Bogor recorded coverage levels below the average (82.5% and 87.9%), yet their stunting prevalence remained high (4.1% and 3.9%), indicating

that intervention implementation has not been optimal. In contrast, South Bogor, East Bogor, and North Bogor showed coverage above 92% with lower prevalence rates (1.7–2.5%), suggesting that nutrition programs are functioning more effectively. Tanah Sareal also supports this pattern, with high coverage (94.5%) and moderate prevalence (2.5%). These findings highlight that broad weighing coverage must be accompanied by high-quality and sustained interventions to achieve a significant reduction in stunting.

Evaluation of the Effectiveness of Intervention Programs

The evaluation of the effectiveness of stunting intervention programs in the City of Bogor for the 2022–2024 period was conducted by comparing child weighing coverage and stunting prevalence. The analysis results show a positive trend: weighing coverage increased from 88.83% in 2022 to 99.49% in 2024, while stunting prevalence decreased from 3.32% to 2.35%. This indicates that routine programs, such as growth monitoring at Posyandu, supplementary feeding, vitamin A distribution, and nutrition education, have contributed to improving the nutritional status of children under five.

However, sub-district-level analysis reveals fluctuations. For example, in Central Bogor, prevalence increased in 2023 before declining again. This phenomenon indicates the presence of external factors influencing program effectiveness, such as household economic conditions, community participation, the quality of health services, and supporting facilities.

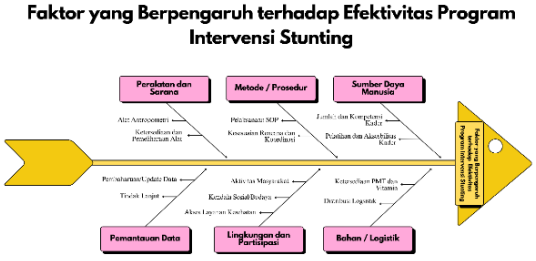

Figure 13. Fishbone Diagram Analysis

Based on the fishbone root cause analysis, there are six main factors influencing the effectiveness of stunting intervention programs in the City of Bogor, namely:

a. Human Resources (HR)
   Based on data and program monitoring documents obtained from the Bogor City Health Office (2022–2024), Posyandu cadres play a central role in program implementation. On average, there are 8 cadres per Posyandu who have been trained in 25 basic competencies. However, despite the sufficient number of cadres and regular training, the utilization of services by the community is not evenly distributed. Some cadres must conduct home visits because family awareness to attend Posyandu is still low. This indicates that cadre competence needs to be balanced with increased community awareness and participation.
b. Methods/Procedures (SOP)
   The existence of SOPs in health centers (Puskesmas) and Posyandu serves as an important standard for weighing, recording, and case follow-up. Cross-sector coordination (health centers, village government, cadres) supports smooth program implementation. However, if SOPs are not followed consistently, field implementation may become inconsistent, which can hinder the achievement of targets.
c. Equipment and Facilities
   Complete, standardized, and well-maintained anthropometric measurement tools are essential to ensure accurate child growth data. Regular maintenance and repair ensure that equipment is ready for use. Without adequate equipment, early detection of stunting cannot be carried out optimally, thereby affecting the quality of interventions.
d. Materials/Logistics
   Supplementary feeding (PMT), vitamins, and other supporting logistics must be available and distributed evenly. Timeliness of distribution is also important so that target children receive interventions as needed. Distribution barriers can potentially reduce program effectiveness, even when health services are available.
e. Environment and Community Participation
   Social and cultural factors influence program success. Some families do not optimally utilize Posyandu services, some refuse hospital referrals, and there are challenges related to health insurance (BPJS) ownership. In addition, parenting practices and infant feeding habits are influenced by education levels and parental behavior. Low family participation in balanced nutrition practices is one of the reasons why stunting rates remain high in certain areas.
f. Data Monitoring
   An accurate and regularly updated data system enables health workers to monitor the nutritional status of children effectively. However, the effectiveness of monitoring largely depends on the follow-up actions taken. If data are not accompanied by direct interventions, such as referrals to healthcare facilities or the provision of supplementary feeding, the success of the program becomes limited.

From the fishbone analysis, it can be concluded that the main issue in the effectiveness of stunting intervention programs in the City of Bogor lies not only in the availability of programs but also in the low utilization of services by the community and the suboptimal follow-up of existing systems. Although cadres are sufficient, SOPs are available, and logistics

are prepared, program success is often constrained by low community participation, inappropriate parenting practices, and barriers to accessing healthcare services, such as referrals and BPJS ownership. To address these issues, strategies are needed to strengthen community education and empowerment, improve more inclusive access to healthcare services, and implement data-driven monitoring followed by concrete interventions. With this approach, programs will not only be administrative in nature but will also directly address the needs of target families, enabling a more equitable reduction in stunting across all regions.

CONCLUSION

Research on the prevalence and effectiveness of stunting intervention programs in the City of Bogor shows that, although a declining trend in stunting cases was observed during 2022–2024, the challenges remain complex and multidimensional. The data indicate a reduction in the number of stunting cases from 2,363 in 2022 to 1,588 in 2024, representing an absolute decrease of 775 cases or approximately 32.8%. During the same period, the average prevalence declined from 3.32% to 2.35%. These findings suggest that various intervention efforts, including child growth monitoring, supplementary feeding programs, nutrition education, and vitamin distribution, have contributed positively to stunting reduction in the City of Bogor.

The Root Cause Analysis (RCA) identified six key factors influencing program effectiveness: (1) the number and competence of Posyandu cadres that are not yet fully matched by community awareness and participation, (2) standardization of procedures and cross-sectoral coordination, (3) the availability and adequacy of anthropometric measurement equipment, (4) targeted distribution of supplementary feeding (PMT) and vitamins, (5) family participation and nutritional literacy, and (6) data accuracy and the timeliness of follow-up in case monitoring. These findings indicate that the success of stunting intervention programs depends not only on the availability of services but also on the effectiveness of implementation, community engagement, and data-driven decision-making.

The spatial analysis further reveals variations among sub-districts. West Bogor should be prioritized because it contributes the largest proportion of stunting cases in the city. Meanwhile, Central Bogor requires special attention due to its relatively high prevalence and historically lower child weighing coverage compared with other sub-districts. These findings highlight the importance of prioritizing interventions based not only on the number of cases but also on prevalence levels and service coverage indicators.

Based on the study findings, future program improvement should focus on strengthening digital monitoring and evaluation systems. The development of an integrated stunting monitoring dashboard, automated data validation mechanisms, sub-district risk mapping, and case follow-up notification systems could support more accurate monitoring, faster response to identified cases, and evidence-based policy formulation. Such innovations would also facilitate the identification of priority areas and improve coordination among stakeholders involved in stunting prevention and control.

Nevertheless, this study has several limitations. The analysis relied primarily on secondary data obtained from routine monitoring records and program documents, which may contain reporting bias and data quality limitations. In addition, qualitative aspects such as community perceptions, socio-cultural factors, and behavioral determinants were not explored in depth. Therefore, future studies are recommended to integrate quantitative and qualitative approaches to provide a more comprehensive understanding of stunting determinants and to support the development of more effective intervention strategies.

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