JSDS: JOURNAL OF STATISTICS AND DATA SCIENCE
VOLUME 4, No 2, October 2025
e-ISSN: 2828-9986
https://ejournal.unib.ac.id/index.php/jsds/index

Analysis of Effective Policy Strategies to Address Multidimensional Stunting Using the Biplot Method in Bengkulu Province

Regina Adelisa[1], Vivi Elvira Sahputri Syah [2], Gihon Nakata Silaen [3], Firdaus [4*], Teuku Fahrulriza [5], Eko Fajariyanto [6], and Novrian Pratama [7]

[1,2,4] (S1 Statistics Study Program, Bengkulu University, Indonesia)
[3] (Department of Statistical Computing, Polytechnic Statistics STIS, Indonesia)
[5,6,7] (BPS-Statistics Indonesia Bengkulu Province, Indonesia)

* Corresponding Author: fir.daus@unib.ac.id

Article Info

Article History:
Received: 10 04 2025
Revised: 12 11 2025
Accepted: 12 29 2025
Available Online: 12 30 2025

Key Words:
Stunting
Biplot
PCA
Bengkulu

Abstract

This study aims to analyze the factors contributing to stunting in Bengkulu Province. The method used is biplot analysis, by reducing the Principal Component Analysis (PCA) dimensions into two components. A quantitative approach was employed, involving ten variables representing health, nutrition, education, housing, food security, and social protection factors. The results indicate that Bengkulu City has characteristics that are significantly different from other regencies. The key contributing factors include limited access to basic health services (particularly the availability of skilled birth attendants and immunization coverage), high levels of food insecurity, low access to proper sanitation and safe drinking water, limited practice of exclusive breastfeeding, and low utilization of government assistance programs such as BPJS Kesehatan (National Health Insurance) and KPS/KKS (Social Welfare Cards). It is expected that the findings of this study can provide valuable insights and contribute to efforts in reducing the prevalence of stunting in Bengkulu Province.

1. INTRODUCTION

Stunting is a growth disorder in children characterized by a height that is significantly below the standard for their age. This condition is measured by comparing a child's height to their age, and a child is classified as stunted if the result falls more than two standard deviations below the median of the World Health Organization (WHO) growth standards. Stunting generally occurs during the first 1,000 days of life, from pregnancy to the child's second birthday, and is influenced by various factors such as socioeconomic status, nutritional intake, infections, maternal nutrition, communicable diseases, micronutrient deficiencies, and environmental conditions [1].

Early childhood stunting is a serious public health issue that requires special attention from multiple stakeholders [2]. Stunting generally begins during pregnancy and can continue at least through the first two years after birth. Childhood stunting reflects the overall level of well-being and serves as an indicator of social inequality[3]. Stunting can have negative consequences for children, both in the short and long term[4]. In the short term, stunting hinders brain development, intelligence, physical growth, and body metabolism. In the long term, it can reduce cognitive abilities, academic performance, and immune strength, thereby increasing the risk of chronic diseases such as heart disease, diabetes, stroke, and cancer in adulthood[5]. Stunting not only affects individuals who experience it but also has a significant impact on a country's economic growth and overall development progress[6]. The Global Nutrition Targets 2025 include six main goals, one of which is to reduce the number of stunting cases among children. In line with Indonesia's Sustainable Development Goals (SDGs) target for 2030, the government aims to achieve "zero" stunting cases. Although the stunting rate has shown a declining trend over the years, efforts to accelerate its reduction must continue to ensure that this goal is achieved within the designated timeframe [7]. However, field conditions show that progress toward this target remains insufficient. Over the past decade, stunting prevalence in Indonesia has remained relatively high. Data from the Ministry of Health's Indonesian Nutrition Status Survey (SSGI) indicate that national stunting prevalence in 2023 was 21.5%, which dropped to 19.8% in 2024 — though this figure still exceeds the National Medium-Term Development Plan (RPJMN) target of 14% by 2029. The President of Indonesia has

made stunting reduction a national development priority, launching various nutritional and health intervention programs

The stunting prevalence in Bengkulu Province continues to pose a major challenge. According to the Ministry of Health, Bengkulu's stunting prevalence was 18.8%, which, although lower than the national rate, still reflects a serious issue relative to the reduction targets [8]. In Bengkulu City, significant progress was recorded, with prevalence decreasing from 12.9% in 2022 to 6.7% in 2023. This improvement is encouraging but underscores the need for continued efforts in other regencies and cities. The Ministry of Health, through SSGI and the Indonesian Health Survey (SKI), defines stunting based on height-for-age (HFA) indicators.

The BPS-Statistics Indonesia, in the Special Index for Stunting Management (IKPS) 2022–2023 Volume 5 [9] emphasizes that the causes of stunting are multidimensional, encompassing health, nutrition, housing, food, education, and social protection:

1. The health dimension includes immunization, skilled birth attendance in health facilities, and modern family planning (FP).
2. The nutrition dimension includes exclusive breastfeeding (EBF) and complementary feeding (MP-ASI).
3. The housing dimension includes access to safe drinking water and proper sanitation.
4. The food dimension includes food insecurity and inadequate food consumption.
5. The education dimension includes early childhood education (PAUD).
6. The social protection dimension includes ownership of National Health Insurance (JKN)/regional health insurance (Jamkesda) and receipt of Social Protection Cards (KPS/KKS) or food assistance.

One analytical approach that can be applied is the Biplot method. Biplot analysis provides a graphical representation of data matrix X in a two-dimensional plot, where row vectors represent observed objects, and column vectors represent variables. This visualization reveals the relationships among objects, the variability and correlations among variables, and the associations between them. Biplot analysis can simultaneously visualize the relationships among various factors contributing to the prevalence of stunting, making the patterns of interrelations clearer [10]. Through this approach, complex interactions across multidimensional determinants can be examined, enabling the identification of clusters with similar structural characteristics and the recognition of variables that demonstrate strong correlations in influencing stunting prevalence. This comprehensive visualization supports a deeper understanding of data structures that may not be captured through conventional numerical analysis. This method is useful for identifying which factors are dominant and should be prioritized in policy formulation [10].

Several studies on multidimensional stunting in Indonesia have been conducted. For example, Romadona et al. examined strategies for stunting prevention and management through early childhood education (PAUD) teacher training [4]. Using a mixed-method approach involving 150 teachers, the study found significant improvements in teachers' knowledge and skills in identifying, preventing, and managing stunting. This finding indicate that such training is vital to accelerate stunting reduction in Indonesia.

In Bengkulu, various studies have also explored innovative stunting interventions. For instance, Siagian et al. implemented an intervention in Mesigit Village, North Bengkulu, through the provision of nutritious foods like mung bean porridge to improve children's nutrient intake [11]. Meanwhile, Sihombing discussed the use of digital innovation in North Bengkulu through the Si-AMAZING application, which facilitates monitoring of stunting cases and integrates both sensitive and specific intervention programs such as improving sanitation, housing quality, and community health post (posyandu) activities [12].

These examples demonstrate that cross-sector collaboration and technology utilization can accelerate stunting reduction. Therefore, this article aims to serve as both a scientific and practical reference for formulating stunting management policies in Bengkulu. By integrating conceptual understanding, national and local data, official indicators, analytical approaches using the Biplot method, and field best practices, this study seeks to contribute to achieving the zero stunting target in Bengkulu Province.

2. METHOD

This study employs a quantitative descriptive approach to understand and map the multidimensional factors contributing to stunting. The main objective of the research is to identify independent variables that cause stunting and to analyze how these variables are interrelated, which will later serve as the basis for policy recommendations for each district and city in Bengkulu Province. By applying a quantitative approach, the study focuses on the collection of numerical data and statistical analysis to describe the patterns and distribution of stunting across different regions. The use of this method is expected to provide a more accurate depiction as a key foundation for reducing stunting prevalence in various districts and cities of Bengkulu Province.

The Biplot analysis technique is applied to interpret the relationships among variables as well as between variables and regions within a two-dimensional plot. Through Biplot analysis, this study is able to visualize the similarities in stunting characteristics among districts/cities and identify correlations among independent variables influencing stunting. The results of the analysis are expected to offer a more holistic understanding of stunting prevalence across regions and provide relevant information as a foundation for formulating more targeted policy interventions to support stunting reduction efforts.

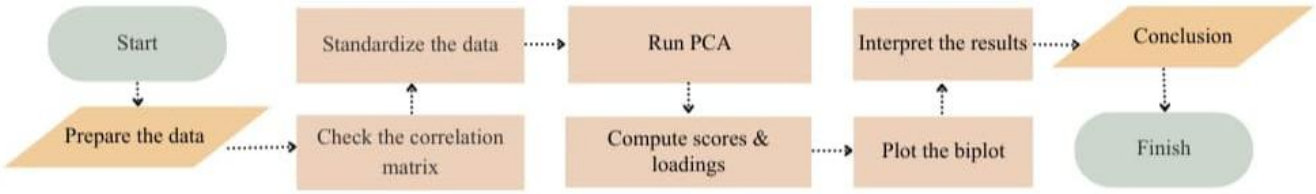

Figure 1. Biplot Construction Flowchart

The population of this research includes all districts and cities in Bengkulu Province for the year 2024. Accordingly, this study focuses on mapping and analyzing stunting at the district/city level in Bengkulu Province to obtain a comprehensive representation of the factors affecting stunting in the region. This approach enables the study to understand variations in stunting characteristics and their associations with independent variables across districts/cities, providing more locally specific insights.

The sample of this study consists of secondary data on stunting obtained from the BPS-Statistics Indonesia, including the Social Welfare Statistics [13] and Maternal and Child Health Statistics [14] based on the National Socio-Economic Survey (SUSENAS), Bengkulu in Figures 2024 [15], and the Indonesian Nutrition Status Survey (SSGI) in Figures 2024 published by the Ministry of Health [8]. Additional data were sourced from the Gross Enrollment Rate (GER) and Net Enrollment Rate (NER) reports for 2023/2024 issued by the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek). The dataset encompasses all 10 districts and cities in Bengkulu Province, ensuring comprehensive regional representation. Utilizing these secondary data sources enables objective, accurate, and valid analysis, providing a solid foundation for formulating effective, evidence-based policies to reduce stunting prevalence. The variables analyzed in this study are as follows:

Table 1. Research Variables and Dimensions Related to Stunting

Dimension	Variable Name	Unit	Source
–	Prevalence of Malnutrition among Children Under Five in Bengkulu Province Based on Nutritional Status (Stunting) (Y)	Percentage	Ministry of Health of the Republic of Indonesia
Health	Percentage of children aged 12–23 months receiving Complete Basic Immunization (CBI) (X1)	Percentage	BPS-Statistics Indonesia Bengkulu Province
	Percentage of ever-married women aged 15–49 whose last delivery was assisted by trained health personnel in a health facility (X2)	Percentage	
	Proportion of women of reproductive age (15–49 years) or their sexually active partners who wish to delay or stop having children and use modern contraceptive methods (X3)	Percentage	

Nutrition	Percentage of infants aged 0–5 months who are exclusively breastfed (X4)	Percentage	BPS-Statistics Indonesia Bengkulu Province
Housing	Percentage of households with access to safe drinking water (X5)	Percentage	BPS-Statistics Indonesia Bengkulu Province
	Percentage of households with access to proper sanitation (X6)	Percentage	
Food Security	Prevalence of population experiencing moderate or severe food insecurity (Food Insecurity Experience Scale – FIES) (X7)	Percentage	BPS-Statistics Indonesia Bengkulu Province
Social Protection	Percentage of population covered by BPJS (National Health Insurance) (X8)	Percentage	BPS-Statistics Indonesia Bengkulu Province
	Percentage of households receiving KPS/KKS (Social Assistance Card) (X9)	Percentage	
Education	Gross Enrollment Rate (GER) for Early Childhood Education (PAUD) ages 3–6 years (X10)	Percentage	Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia

Biplot analysis was selected as the most appropriate method for this study. According to Jolliffe, Biplot Analysis is a descriptive statistical method that represents data consisting of n objects and p variables into a two-dimensional graphical form. From this graph, it is possible to analyze the characteristics of both objects and variables, as well as the relative position of the objects concerning their variables[16].

In the context of this research, the objects refer to the districts/cities in Bengkulu Province, while the variables represent the multidimensional factors suspected to be related to stunting prevalence. Thus, Biplot analysis enables visualization of the relationships among stunting determinants and provides an overview of the profile differences across districts/cities. The equation can be written as follows:

$$X = U\Sigma V' \tag{1}$$

The explanation of the equation above is as follows:

X = A matrix with a size of $n \times p$

U = A matrix with a size of $n \times r$

Σ = A matrix with a size of $r \times r$

V = A matrix with a size of $p \times r$

U and V matrix is an orthonormal matrix, meaning that the multiplication of the matrix by its transpose results in an identity matrix. U matrix has values in which each of its columns is a left singular vector, the matrix Σ is a diagonal matrix whose values are the square roots of the eigenvalues XX' and V matrix is a matrix whose columns are the eigenvectors of XX'. If we introduce the value of $0 \leq \alpha \leq 1$ such that:

$$\Sigma = \Sigma^{\alpha}\Sigma^{1-\alpha} \tag{2}$$

Then we can express the equation as follows:

$$X = U\Sigma^{\alpha}\Sigma^{1-\alpha}V' = GH' \tag{3}$$

Where the formula are $G = U\Sigma^{\alpha}$ and $H' = \Sigma^{1-\alpha}V'$

If we take the first two columns from the matrix and we will obtain the values of the principal component scores for each data point and the values of from the variables used.

3. RESULTS AND DISCUSSION

The study uses 10 independent variables representing multidimensional factors influencing stunting prevalence. The health dimension includes complete basic immunization coverage for children aged 12–23 months (X1), delivery assistance by health professionals (X2), and family planning or modern contraceptive use (X3). The nutrition dimension is represented by the percentage of infants aged 0–5 months receiving exclusive breastfeeding (X4). The housing/environment dimension covers household access to safe drinking water (X5) and proper sanitation (X6), both crucial for hygiene and disease prevention. The food security dimension is measured by the prevalence of moderate or severe food insecurity (X7), indicating community food availability. The social protection dimension

includes BPJS Health coverage (X8) and KPS/KKS recipient households (X9), reflecting support for vulnerable populations. Lastly, the education dimension uses the Gross Enrollment Rate (GER) of early childhood education (PAUD) for ages 3–6 (X10), reflecting early human capital development.

These variables collectively capture the multifaceted nature of stunting in Bengkulu Province. Limited immunization, inadequate delivery care, and low contraceptive use increase maternal and child health risks. Poor breastfeeding practices, unsafe water, and food insecurity worsen child nutrition and growth. Meanwhile, low PAUD participation restricts early learning and nutrition awareness, while limited social protection weakens household access to health and food—highlighting the need for integrated, cross-sectoral interventions.

Thus, stunting is a multidimensional issue influenced by interrelated factors across health, nutrition, environment, education, food security, and social protection, and it cannot be addressed in isolation.

Table 2. Descriptive Statistics

Variable	Min	Median	Mean	Max
Stunting (Y)	15,9	21,35	20,34	24,7
Immunization (X1)	41,48	80,92	75,75	90,43
Health Assistance (X2)	88,08	96,64	95,23	100
Modern Contraception (X3)	47,05	66,62	64,97	73,01
Exclusive Breastfeeding (X4)	46,89	71,54	72,26	100
Drinking Water Access (X5)	50,44	69,36	69,16	92,21
Sanitation Access (X6)	59,38	84,88	81,17	96,15
Food Insecurity (X7)	5,56	10,38	10,26	13,7
BPJS Coverage (X8)	35,98	46,52	49,43	67,82
KPS/KKS Assistance (X9)	11,09	15,41	16,56	22,93
PAUD Gross Enrollment Rate (X10)	35,62	42,62	47,41	72,17

The descriptive analysis indicates that stunting prevalence (Y) in Bengkulu Province ranges from 15.90% to 24.70%, with an average of 20.34%, reflecting regional disparities. Immunization coverage (X1) is relatively high at 75.75%, and birth assistance by health professionals (X2) reaches 95.23%, showing strong healthcare service performance. Modern contraceptive use (X3) and exclusive breastfeeding (X4) average 64.97% and 72.26%, respectively, though variations exist, such as 100% exclusive breastfeeding in Lebong Regency. Access to safe drinking water (X5) and sanitation (X6) are adequate, averaging 69.16% and 81.17%, while food insecurity (X7) remains low at 10.26%. However, social protection coverage is moderate, with BPJS participation (X8) at 49.43% and KPS/KKS assistance (X9) at 16.56%. Early childhood education enrollment (X10) averages 47.41%, suggesting room for improvement. Overall, while healthcare and environmental indicators are strong, gaps persist in breastfeeding practices, social protection, and early education—key areas that must be strengthened to reduce stunting in a multidimensional framework.

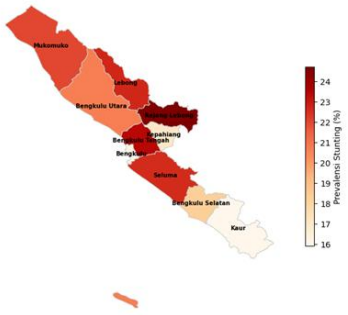

Figure 2. Thematic Map of Districts/Cities in Bengkulu Province

The thematic map above illustrates the prevalence of stunting at the district/city level in Bengkulu Province. The colors indicate prevalence levels, with darker shades representing higher stunting prevalence and lighter shades representing lower prevalence. The scale is categorized as low (starting from cream), medium (starting from pink), and high (dark red). The districts/cities are classified based on these color scales as follows:

1. Highest Stunting Prevalence
   Found in Rejang Lebong, Central Bengkulu, and Lebong. These areas face serious nutrition and health challenges due to limited access to nutritious food, poor sanitation, and insufficient maternal–child health services. Strengthened interventions in nutrition programs, health service access, and sanitation improvement are urgently needed.
2. Medium Stunting Prevalence
   Occurs in Seluma, Mukomuko, North Bengkulu, and South Bengkulu. Contributing factors include uneven food distribution and limited health education. Efforts should focus on nutrition education, breastfeeding promotion, and equitable access to basic health services.
3. Lowest Stunting Prevalence
   Found in Kepahiang, Bengkulu City, and Kaur. These areas have benefited from better food access, effective health programs, and strong community awareness. Continued preventive efforts are essential, and their success can serve as a model for other regions.

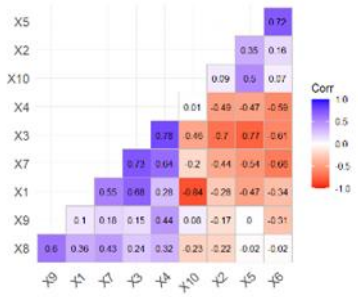

Figure 3. Correlation Matrix Among Variables

The figure above shows the correlation matrix among variables influencing stunting prevalence, with blue indicating positive correlation, white no correlation, and red negative correlation, where darker shades reflect stronger correlations. The use of modern contraceptives (X3) has a strong positive correlation with moderate/severe food insecurity (X7, 0.73) and exclusive breastfeeding (X4, 0.78), suggesting that better reproductive health education is linked to awareness of proper nutrition. Strong negative correlations are observed between immunization coverage (X1) and PAUD enrollment (X10, -0.84), and between contraceptive use (X3) and access to safe drinking water (X5, -0.77), indicating that lower immunization or higher contraceptive use can coincide with lower early education participation or limited water access. Overall, these correlations suggest that regions with better food and water security tend to have higher awareness and use of modern contraceptives.

Before proceeding with the PCA analysis, we first check the assumptions to determine whether the available data are suitable for PCA. The assumptions to be tested include the KMO/MSA measure and Bartlett's test. The results are presented in the table below.

Table 3. PCA Assumption Test

Test Used	Test Statistic
Data Adequacy (KMO/MSA)	KMO/MSA = 0,5
Correlation among Variables (Bartlett)	*p-value* = 0,000

The KMO/MSA test (value = 0.5) indicates that the data are suitable for factor analysis. The Bartlett test, with a p-value < 0.001, rejects the null hypothesis, confirming significant correlations among variables. Thus, PCA can be appropriately applied to reduce correlated variables into lower-dimensional components.

With the fulfillment of the two main assumptions for conducting PCA—adequate KMO/MSA and significant correlations among variables—the next step is to perform the PCA analysis. PCA is conducted to reduce the dimensionality of the data so that each observation can be well represented by the reduced dimensions. The results of the PCA are presented in the table below.

Table 4. PCA Results

	PC1	PC2	PC3	PC4
Standard Deviation	22	13	12	0,9663
Proportion of Variance	0,4692	0,1724	0,143	0,09337
Cumulative Proportion	0,4629	0,6416	0,7845	0,8779

The table shows that PC1, PC2, PC3, and PC4 explain 46.92%, 17.24%, 14.3%, and 9.34% of the total variance, respectively. Together, PC1 and PC2 account for 64.16% of the data variability, which is sufficient for a biplot. Cumulatively, the four components explain over 80% of the total variance, indicating that they effectively capture the main structure and variability of the dataset.

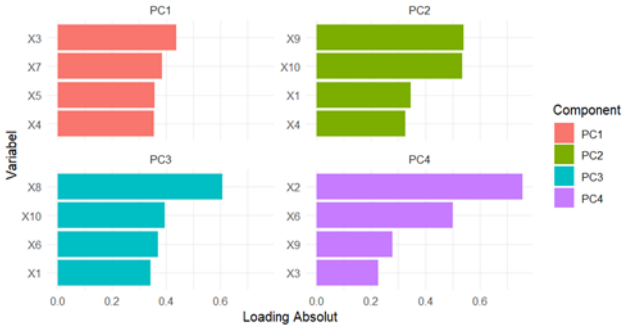

Figure 4. Top-Contributing Variables in PC1–PC4

The figure highlights the key variables contributing to each principal component. PC1, dominated by modern contraceptive use (X3), food insecurity (X7), access to safe drinking water (X5), and exclusive breastfeeding (X4), is labeled as the Food Security & Health component. PC2, influenced by KPS/KKS recipients (X9), early childhood education enrollment (X10), complete immunization (X1), and exclusive breastfeeding (X4), represents Child Social Programs & Protection. PC3, shaped by BPJS coverage (X8), early education participation (X10), sanitation access (X6), and immunization coverage (X1), is identified as Social Insurance & Basic Protection. Finally, PC4, driven by trained delivery assistance (X2), sanitation access (X6), KPS/KKS recipients (X9), and modern contraceptive use (X3), reflects Delivery Services & Household Conditions.

The PCA results obtained will be used for Biplot analysis. The principle of Biplot is to represent a two-dimensional space where the x-axis and y-axis correspond to the first and second principal components, respectively. Each variable is represented as a vector, with its length indicating the variable's contribution to the axes.

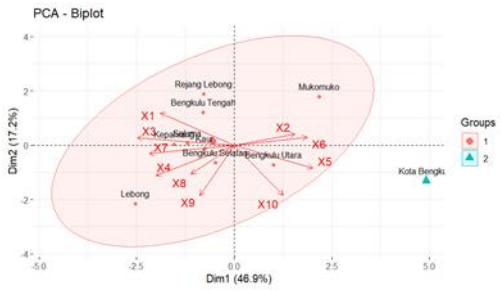

Figure 5. Biplot

The biplot in Figure X illustrates the distribution of stunting-related variables and the position of each district/city in Bengkulu Province based on two principal components, namely PC1 and PC2. The first principal component (PC1), which serves as the horizontal axis, captures 46.9% of the total variance, while the second principal component (PC2), represented by the vertical axis, contributes 17.2% of the variance. Together, both components explain 64.1% of the total variability in the dataset, indicating that they adequately represent the multidimensional structure of the data for interpretation.

The biplot simultaneously displays ten variables as vectors and ten districts/cities as points, allowing for the joint interpretation of variable relationships and regional characteristics. The following sections elaborate on four key aspects of interpretation:

1. Distance Among Districts and Cities
   The biplot shows clear regional distinctions in stunting-related factors. Bengkulu City stands out, characterized by strong health infrastructure, sanitation, and early education (X2, X5, X6, X10), but lower performance in preventive health and nutrition (X1, X3, X4, X7, X8, X9). Mukomuko and North Bengkulu share similar strengths in infrastructure and education but remain weak in nutrition and social protection. Lebong lies opposite Bengkulu City, excelling in immunization, contraception, and breastfeeding (X1, X3, X4), yet facing food insecurity despite wide social protection access. Kepahiang, Seluma, Kaur, and South Bengkulu cluster together, showing good awareness of family planning and breastfeeding but persistent food insecurity. Rejang Lebong and Central Bengkulu show strong immunization but low access to safe water, early education, and social aid.
2. Variable Vectors and Regional Characteristics
   Vector direction and length indicate how each variable contributes to regional profiles. Bengkulu City aligns with X2, X5, X6, and X10, reflecting strong infrastructure and education. Lebong aligns with X4, X8, and X9, indicating higher breastfeeding rates and social aid participation.
3. Variable Contribution
   Key differentiating variables are X1 (immunization), X3 (contraception), X5 (safe water), and X10 (education), as shown by their longer vectors. Shorter vectors (X2, X8) indicate smaller regional variation.
4. Correlation Among Variables
   Smaller angles reflect positive correlations, e.g., X3 and X7 (contraception–food insecurity), X2 and X6 (health workers–sanitation). Opposite directions like X1 and X5 indicate negative relationships, while near-right angles (X8 and X10) suggest weak correlations.

After explaining the general points that can be interpreted from the biplot and the characteristics of stunting-related factors depicted in the figure, we can provide a specific interpretation for each regency/city based on their regional characteristics. Below is district-specific interpretations and policy recommendations:

1. Bengkulu City: Despite strong health infrastructure, Bengkulu City struggles with low immunization, contraceptive use, and exclusive breastfeeding rates. Solutions include community-based education involving local leaders, training for breastfeeding mothers, and expanding BPJS Health participation to improve preventive health behavior and reduce stunting.
2. North Bengkulu: Low immunization awareness and limited contraceptive use persist due to low education levels. Strategies include strengthening local health campaigns, empowering midwives and posyandu cadres, and integrating health education into community and religious events to increase participation.
3. Mukomuko: Weak breastfeeding practices and low BPJS/social aid participation characterize Mukomuko. Strengthening breastfeeding counseling, expanding BPJS enrollment, and integrating health with social programs will enhance maternal and child health while reducing stunting risks.
4. Lebong: Lebong faces limited health facilities, inadequate sanitation, and high food insecurity. Efforts should focus on improving health infrastructure, increasing skilled birth attendants, enhancing sanitation and hygiene, and implementing nutrition education and food aid programs.
5. South Bengkulu: Near the provincial average, South Bengkulu still needs improvements in sanitation and clean water access. Expanding sanitation infrastructure, promoting hygiene education, and ensuring clean water availability are key to reducing stunting.

6. Kaur: Kaur suffers from a shortage of skilled birth attendants and high food insecurity. Strategies include recruiting and training local midwives, strengthening maternal services, and expanding food security and nutrition programs.
7. Seluma: Similar to Kaur, Seluma requires improved maternal health coverage and food access. Increasing trained birth attendants and integrating nutrition-based social aid can enhance child nutrition and reduce stunting.
8. Kepahiang: High food insecurity and poor sanitation are major issues. Priorities include expanding nutritious food programs, improving clean water infrastructure, and promoting safe water practices through community education.
9. Central Bengkulu: Limited safe water access and low early education participation are key challenges. Strategies include clean water infrastructure improvement, public awareness on water safety, and expansion of early education facilities.
10. Rejang Lebong: Limited access to BPJS and KPS/KKS amid high food insecurity calls for expanding social protection programs, ensuring accurate targeting, and enhancing nutrition support to improve household welfare and reduce stunting.

4. CONCLUSION

The multidimensional analysis of stunting in Bengkulu Province reveals significant inter-district disparities. Major contributing factors include limited health services, high food insecurity, inadequate sanitation and clean water, low exclusive breastfeeding rates, and limited access to BPJS Health and KPS/KKS programs. Specific issues include health personnel shortages in Kaur, Seluma, and Lebong; food insecurity in Kepahiang; poor water access in Central Bengkulu; and low health awareness in Bengkulu City. Overall, stunting in Bengkulu arises not only from economic factors but also from structural and behavioral challenges.To address these challenges, five strategic directions are proposed:

1. Strengthen maternal and child health services through village midwives, posyandu activation, and home visits.
2. Enhance food security via household nutrition gardens, subsidized food, and nutrition education.
3. Improve water and sanitation infrastructure with clean water programs and healthy latrine initiatives.
4. Increase education and awareness through early nutrition education and community campaigns.
5. Expand social protection and healthcare access by extending BPJS coverage and improving aid targeting.

In conclusion, reducing stunting in Bengkulu requires an integrated, cross-sectoral approach that combines health, education, agriculture, and social protection programs to achieve sustainable improvements in child nutrition and development.

ACKNOWLEDGMENTS

The author would like to express his deepest gratitude to the Central Statistics Agency (BPS), the Ministry of Health (Kemenkes), and the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) for providing crucial data, which without this research would not have been possible. The author also extends appreciation and gratitude to the internship supervisor and field supervisor for all the time, guidance, direction, and constructive feedback provided throughout the research process.

REFERENCES

[1] World Health Organization, *Reducing stunting in children: equity considerations for achieving the Global Nutrition Targets 2025*. 2018.

[2] N. F. Rahmawati, N. A. Fajar, dan H. Idris, "Faktor sosial, ekonomi, dan pemanfaatan posyandu dengan kejadian stunting balita keluarga miskin penerima PKH di Palembang," *J. Gizi Klin. Indones.*, vol. 17, no. 1, hal. 23, 2020, doi: 10.22146/ijcn.49696.

[3] D. Aryani, D. Andarini, H. Idris, dan R. Anggraeni, "Hubungan Status Stunting dengan Faktor Ekonomi : Literature Riview," *J. Lentera Kesehat. Masy.*, vol. 3, no. 1, hal. 45–52, 2024.

[4] N. F. Romadona, O. Setiasih, A. Listiana, E. Syaodih, dan R. Rudiyanto, "Strategi Pencegahan dan Penanganan Stunting Multidimensi melalui Pelatihan Guru PAUD," *J. Obs. J. Pendidik. Anak Usia Dini*, vol. 7, no. 6, hal. 7241–

7252, 2023, doi: 10.31004/obsesi.v7i6.5724.
[5] Sri Nur Riska, Wiwit Pura Nurmayanti, dan Hanipar Mahyulis Sastriana, "Penerapan Analisis Multidimensional Scaling Terhadap Angka Stunting Di Kabupaten Lombok Timur," *J. Eksbar*, vol. 1, no. 1, hal. 48–63, 2024, doi: 10.29408/eksbar.v1i1.27115.
[6] A. Yunita, R. H. Asra, W. Nopitasari, R. H. Putri, dan R. Fevria, "Hubungan Sosial Ekonomi Dengan Kejadian Stunting Pada Balita," *Pros. Semin. Nas. Biol.*, vol. 2, no. 2, hal. 812–819, 2023, [Daring]. Tersedia pada: https://semnas.biologi.fmipa.unp.ac.id/index.php/prosiding/article/view/519
[7] D. E. Hendraswari, "Studi Ekologi : Determinan Kejadian Gizi Buruk Di Indonesia Tahun 2021," *J-KESMAS J. Kesehat. Masy.*, vol. 9, no. 1, hal. 84, 2023, doi: 10.35329/jkesmas.v9i1.3899.
[8] Kementerian Kesehatan RI, *Survei Status Gizi Nasional (SSGI) 2024*, vol. 17. Jakarta, 2024.
[9] BPS Provinsi Bengkulu. *Laporan Indeks Khusus Penanganan Stunting (IKPS) 2022-2023*. Bengkulu, 2024.
[10] Nugroho S, *Statistika Mutivariat Terapan*. 2008.
[11] T. A. Siagian *et al.*, "Upaya Penanganan Stunting Di Desa Mesigit Penanganan Stunting Kepada Masyarakat Desa Mesigit , Membagikan Brosur terkait," vol. 5, hal. 72–76, 2024.
[12] Y. N. Sihombing, "Analisis Program Aplikasi Si-Amazing (Sistem Informasi Aksi Masif Zona Stunting) Dalam Menekan Angka Stunting Di Kecamatan Putri Hijau Kabupaten Bengkulu Utara," *J. Soc. Sci. Digit. Mark.*, vol. Vol.5 No.2, no. 2, hal. 22–30, 2024.
[13] S. P. Collins *et al.*, *Statistik Kesejahteraan Rakyat*. 2021.
[14] BPS Provinsi Bengkulu. *Profil Kesehatan Ibu dan Anak Provinsi Bengkulu 2024*, vol. 17. Bengkulu, 2024.
[15] BPS Provinsi Bengkulu. *Provinsi Bengkulu dalam Angka*. 2024.
[16] I. T. Jolliffe, "Principal components," *Data Handl. Sci. Technol.*, vol. 20, no. PART A, hal. 519–556, 1998, doi: 10.1016/S0922-3487(97)80047-0.