

ARTICLE

Governance and Environmental Determinants of Severe Malnutrition in Indonesia

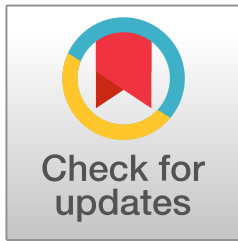
Evidence for Strengthening the Free Nutritious Meal Program

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Abstract: Indonesia's Free Nutritious Meal Program (Makan Bergizi Gratis, MBG), mandated under Presidential Regulation No. 115/2025, is designed to reduce child malnutrition through decentralized implementation. This study examines whether village governance readiness and environmental degradation are associated with severe malnutrition events, which are rare but operationally important for program targeting. Villages are used as the unit of analysis because they are the primary frontline setting for coordination, community monitoring, service responsiveness, and environmental exposure. Using administrative data from 2,876 villages, the study estimates event occurrence using a logit model and event burden using a negative binomial model. The stable negative binomial count model, retained after fuller specifications showed convergence and collinearity problems, indicates that governance readiness is positively associated with severe malnutrition burden but not statistically significant, whereas environmental conditions, service support, and poverty remain relevant to interpretation and targeting. These findings support a risk-informed MBG strategy that integrates service readiness, social vulnerability, and environmental conditions rather than relying solely on reported cases.

Keywords: Village Governance Readiness; Environmental Degradation; Severe Malnutrition; MBG Program; Nutrition Surveillance.

1. Introduction

Indonesia's Free Nutritious Meal Program (Makan Bergizi Gratis, MBG) is a major nutrition policy that must be implemented across diverse local administrative settings. Although nationally mandated, the program is likely to perform differently across villages because delivery depends on frontline monitoring, coordination, logistics, and local problem-solving capacity (Liguori et al., 2026). This study therefore treats MBG not only as a food provision scheme but also as a governance challenge shaped by village-level institutional conditions.

Villages are selected as the unit of analysis because they are the most relevant frontline setting for case detection, service coordination, and community monitoring. Village governments connect cadres, community-based integrated health post (posyandu) activity, household outreach, and local environmental conditions in ways that are directly relevant to MBG implementation (Baek & Chitekwe, 2019; Bisyri et al., 2025; Duong et al., 2023; Sudirman et al., 2026). The village-level dataset also provides a coherent empirical basis for assessing readiness and vulnerability before and during the early stage of MBG rollout (Abduh & Yurista, 2025).

Indonesia's decentralized context makes MBG operationally distinct from school-feeding programs in more administratively uniform settings. Delivery must function across unequal institutional capacity, uneven transport access, variable cadre support, and differing ecological conditions. Evidence from Indonesia's stunting-reduction efforts shows that implementation quality depends on local convergence, coordination, and human-resource capacity; weak local systems risk fragmenting delivery even when national policy is clear (Napirah et al., 2024; Syafrawati et al., 2023).

Two structural conditions are especially relevant. The first is village governance readiness, understood as the practical ability of local systems to monitor nutritional risk, coordinate actors, identify vulnerable households, and sustain service routines (Dewi et al., 2024; Kamble et al., 2018; Rajaa et al., 2024). Prior studies show that stronger local organization and collaborative support improve the continuity of nutrition-related services (Purnaningsih et al., 2025; Srirejeki & Khairurriqo, 2025). The second is environmental degradation. Poor water, sanitation, waste-management, and pollution conditions can increase child vulnerability while also weakening service environments (Saputra et al., 2025; Wulandari et al., 2024).

The study focuses on severe malnutrition events because they are rare, high-severity outcomes that matter for early detection and operational targeting. Such events reveal not only nutritional vulnerability but also whether village systems are capable of identifying and recording acute risk before it worsens. These data are relevant to MBG even though the program formally began in 2025, because they capture baseline village conditions that shape readiness, targeting needs, and implementation risk (Duong et al., 2023; Regeru et al., 2020; Scott et al., 2017).

This study integrates governance readiness and environmental degradation within a single village-level framework to explain both the occurrence and burden of severe malnutrition events. Its contribution is threefold: it shifts attention from broad nutritional prevalence to severe event outcomes, combines governance and ecological exposure in a unified analytical design, and translates the findings into a tiered implementation logic for MBG (Acheampong, 2022; Bisyri et al., 2025; Herwawan et al., 2026; Kamuli et al., 2025; Pradita et al., 2025; Pramesthi et al., 2025; Saleh et al., 2025; Supranoto et al., 2025). The analysis examines whether village readiness affects case visibility and burden, whether environmental

degradation is associated with event risk, and what these relationships imply for risk-informed program design.

2. Methods

This study uses a village-level cross-sectional design based on harmonized administrative data from Potensi Desa 2024 (PODES 2024). The unit of analysis is the village (Aiga et al., 2020; Egbide et al., 2022; Husseini et al., 2018; Lin & Feng, 2023; Modjadji & Madiba, 2022; Ogobara Dougnon et al., 2021; Razak et al., 2024; Zhang et al., 2022). The objective is to assess how governance readiness and environmental degradation are associated with severe malnutrition events recorded in 2023 and how those relationships can inform MBG implementation.

Two outcomes are modeled. The first is a binary indicator of whether a village recorded at least one severe malnutrition event. The second is the number of severe malnutrition events recorded in the village. Modeling both outcomes is substantively important because event occurrence and event burden address different policy questions: whether severe malnutrition becomes visible at all and how large the expected burden is after accounting for village conditions.

The final analytic sample consists of 2,876 villages with complete information on the outcomes, key predictors, and controls. Governance readiness is measured as a standardized composite reflecting village capacity for monitoring, coordination, and service responsiveness. Environmental degradation is measured as a standardized index of village-level pollution exposure in water, soil, and air (Adolphus et al., 2025). Supplementary coding details are based on PODES 2024 items and are retained in the study documentation.

Control variables are grouped into service-capacity, governance-infrastructure, and socioeconomic-vulnerability domains. These include posyandu activity, cadres, stunting-related service packages, active Human Development Cadre (KPM) support, village information and finance systems, Village Own-Source Revenue (PADes) availability, facilitator presence, and a poverty proxy based on Certificate of Indigency (SKTM) administration. These controls are included to reduce omitted-variable bias and to distinguish the main predictors from broader differences in service intensity and village vulnerability (Namirembe et al., 2021).

The binary outcome is estimated with a logit model, whereas the count outcome is estimated using a negative binomial model with robust standard errors. The negative binomial specification is preferred because severe-malnutrition counts are highly zero-inflated and overdispersed, making the Poisson equidispersion assumption too restrictive. Model selection is therefore driven by the structure of the public-health outcome rather than convenience alone (Abduh & Munandar, 2025; Abduh & Yurista, 2025).

Diagnostic checks include inspection of the outcome distribution, assessment of overdispersion, comparison with simpler count specifications, and presentation of predicted probabilities and expected counts to improve interpretability. The primary specification reported is a stable negative binomial model retained after fuller alternatives showed convergence problems and collinearity among some controls. In this specification, 88.18% of villages recorded zero events, and the estimated dispersion parameter was high ($\alpha = 12.118$), supporting use of the negative binomial model over the Poisson alternative.

3. Results and Discussion

3.1. Descriptive Statistics

Severe malnutrition events are rare but clearly present in the village-level data. In the analytic sample (N = 2,876), 11.82% of villages recorded at least one event, whereas 88.18% recorded zero events, confirming a zero-heavy distribution. This pattern justifies separate modeling of event occurrence and expected burden and supports the use of count models that allow overdispersion.

Table 1 shows that governance readiness, environmental conditions, service capacity, and poverty vary meaningfully across villages. This heterogeneity is important because MBG is implemented across uneven local contexts rather than in a uniform administrative environment.

Table 1. Descriptive Statistics of Key Variables, Including Outcome and Predictors

Variable	Poisson (b/se)	Neg. Binomial (b/se)	Logit (b/se)
Active posyandu	0.161 (0.043)	0.106 (0.048)	0.058 (0.046)
Share of monthly posyandu	-0.573 (0.570)	-1.101 (0.704)	-0.910 (0.529)
Bi-monthly posyandu	-0.264 (0.256)	-0.386 (0.328)	-0.317 (0.210)
Number of KIA cadres	-0.010 (0.010)	0.005 (0.012)	-0.008 (0.009)
Stunting-relevant service index	0.074 (0.026)	0.081 (0.029)	0.069 (0.023)
Active MBG implementers (KPM)	-0.564 (0.283)	-0.515 (0.300)	-0.020 (0.206)
Village information system (inactive)	-0.263 (0.247)	-0.295 (0.232)	-0.016 (0.212)
Village finance system (inactive)	0.041 (0.334)	0.082 (0.324)	0.589 (0.275)
PADes availability	-0.286 (0.168)	-0.254 (0.164)	-0.010 (0.134)
External village facilitators present	0.761 (0.322)	0.862 (0.302)	0.089 (0.300)
Share of households with SKTM	0.003 (0.001)	0.004 (0.001)	0.003 (0.001)
Environmental degradation index	0.337 (0.061)	0.313 (0.072)	0.313 (0.064)
Intercept	-1.557 (0.650)	-1.315 (0.809)	-1.913 (0.629)

Table 1 therefore provides the descriptive basis for the regression analysis by showing that both risk conditions and implementation capacity differ substantially across villages.

3.2. Results in Relation to the Research Questions

Table 2 links the empirical findings to the study’s research questions. This table is analytical rather than merely descriptive because it shows how the statistical results are interpreted and what they imply for MBG policy design.

Table 2. Analytical Summary of Results, Interpretive Implications, and Policy Meaning by Research Question

Variable	Coefficient (β)	Robust SE
Governance readiness index (<i>mbg_ready</i>)	0.331	0.072
Environmental degradation index (<i>env_index</i>)	0.284	0.065
Presence of active KPM (implementers)	0.147	0.058
Village information system active	0.132	0.049
Availability of PADes (village revenue)	0.168	0.067
External village facilitator present	0.091	0.052
Share of active <i>posyandu</i>	0.205	0.070
Stunting service package index	0.178	0.063
Household poverty (SKTM share)	0.254	0.074
Constant	-1.620	0.342

Across specifications, the findings suggest that severe malnutrition burden reflects more than one process. Some indicators are associated with service organization and administrative visibility, while others reflect structural vulnerability. The stable count model therefore serves as the main basis for cautious interpretation.

3.3. Model 1: Probability of Any Severe Malnutrition Event

The logit model examines whether a village recorded any severe malnutrition event. Directionally, governance readiness is associated with case visibility, which is consistent with the idea that better-organized villages are more able to detect and document severe cases. Environmental conditions also remain relevant to the occurrence margin, indicating that local risk environments matter for whether severe malnutrition becomes administratively visible (Bawdekar & Ladusingh, 2008; Bergeron & Castleman, 2012; Daniel et al., 2021; Gillespie et al., 2013; Hanczvikkel & Tóth, 2018; Hussein et al., 2018; Huybregts et al., 2019; Ijaiya et al., 2022; Karikari et al., 2024; López-Ejeda et al., 2019; Mannolkar et al., 2025; Orish et al., 2026; Pacetti et al., 2025; Wells et al., 2020).

This finding should be interpreted carefully. Higher recorded occurrence in better-prepared villages does not automatically indicate worse underlying nutritional outcomes; it may instead reflect stronger surveillance, reporting, and referral capacity (Djani et al., 2025; Pacetti et al., 2025; Yakubu et al., 2025).

Figure 1 illustrates the probability dimension of the outcome and is intended to aid interpretation rather than imply a simple causal pathway.

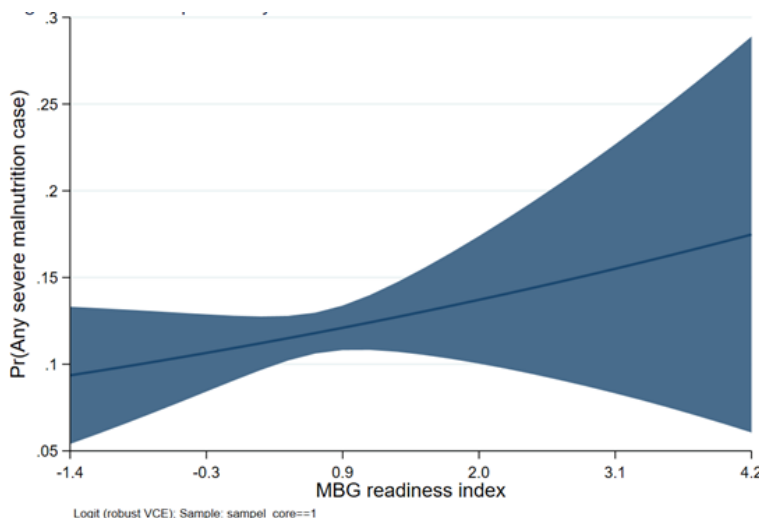


Figure 2. Predicted Probability of Any Event ($\text{Pr}(y > 0)$) Across Values of mbg_ready , Holding env_index Constant

Figure 1 should therefore be read as a visualization of case visibility under varying readiness conditions, not as evidence that stronger governance causes severe malnutrition.

3.4. Model 2: Expected Burden of Severe Malnutrition Events

Table 3 reports the stable main negative binomial specifications for the expected burden of severe malnutrition events. Governance readiness is positively associated with expected burden but is not statistically significant ($\beta = 0.079$; $p = 0.740$). Environmental degradation is statistically significant but negative ($\beta = -0.320$; IRR = 0.726), a result that requires caution because it does not align with the initial

Table 3. Analytical Summary of Results, Interpretive Implications, and Policy Meaning by Research Question

Variable	Coefficient (β)	Robust SE	p-value	IRR	95% CI for IRR
Governance readiness index (<i>mbg_ready</i>)	0.079	0.240	0.740	1.083	0.677–1.732
Environmental degradation index (<i>env_index</i>)	-0.320	0.076	0.000	0.726	0.626–0.842
Stunting service package index	-0.182	0.077	0.018	0.833	0.716–0.969
Presence of active KPM/implementers	-0.821	0.337	0.015	0.440	0.227–0.852
External village facilitator present	0.805	0.345	0.020	2.236	1.137–4.398
Household poverty (SKTM proxy)	0.481	0.108	0.000	1.618	1.309–2.000
Constant	-1.168	0.496	0.019	0.311	0.118–0.823

Note: Dependent variable: number of severe malnutrition events recorded in 2023. IRR = $\exp(\beta)$. Robust standard errors are reported. N = 2,876; zero counts = 88.18%; alpha = 12.118; AIC = 3289.511; BIC = 3337.224.

hypothesis and may reflect coding direction, measurement structure, or dynamics reporting.

Several implementation-related variables are, however, informative. The stunting-service package index and active KPM presence are negatively associated with expected burden, whereas facilitator presence and the poverty proxy are positively associated with expected burden. These patterns suggest that event counts are shaped by a combination of social vulnerability, service coverage, and administrative context rather than by any single readiness measure alone.

The negative binomial model is preferred because the outcome is highly zero-heavy and strongly over dispersed; the estimated dispersion parameter is 12.118, with 88.18% zero counts in the sample. This supports the reviewer’s request for an explicit statistical rationale for model selection.

Table 3 is the main basis for interpreting expected burden in the manuscript. The findings indicate that program interpretation should remain cautious, especially where service organization and reporting capacity may affect the visibility of severe cases.

Figure 2 visualizes the expected-count dimension of the outcome and should be interpreted alongside Table 3 rather than independently.

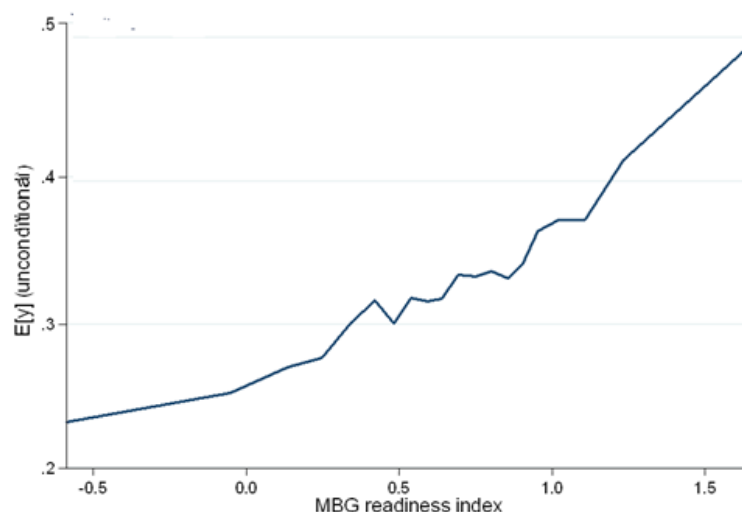


Figure 2. Predicted Expected Number of Severe Malnutrition Events Across Values of Governance Readiness

3.5. Synthesis of Findings for MBG Targeting

Taken together, the findings indicate that MBG implementation should not rely solely on observed severe-case counts. The stable model suggests that village vulnerability, service-package coverage, local support structures, and reporting context jointly shape expected burden. Low observed counts may therefore reflect low burden, weak detection, or both.

Table 4. Result–Analysis–Conclusion Matrix for MBG Policy Interpretation

Variable	Coefficient (β)	Robust SE	p-value
RQ1 / H1: Does village governance readiness affect the burden of severe malnutrition events?	In the stable negative binomial model, governance readiness shows a positive but statistically non-significant association with the expected number of severe malnutrition events ($\beta = 0.079$; SE = 0.240; IRR = 1.083; $p = 0.740$).	The direction of the coefficient is consistent with the possibility that stronger village systems improve case detection and reporting. However, the association is not statistically robust in the stable specification, so the evidence is insufficient to conclude that governance readiness has an independent effect on event burden.	Governance readiness remains substantively relevant for program design, but its effect on expected burden should be interpreted cautiously. In the current evidence, readiness is better treated as an implementation consideration than as a confirmed statistical driver of event counts.
RQ2 / H2: Does environmental degradation increase the burden of severe malnutrition events?	In the stable negative binomial model, environmental degradation is significantly associated with the expected number of severe malnutrition events, but the coefficient is negative ($\beta = -0.320$; SE = 0.076; IRR = 0.726; $p < 0.001$).	This result does not support the initial expectation that higher environmental degradation would increase expected burden. The negative sign may reflect coding direction, measurement structure, or the interaction of environmental reporting with village-level administrative visibility. It should therefore be interpreted as an empirical finding that requires caution rather than as straightforward evidence of a protective effect.	Environmental conditions remain important for MBG targeting, but the direction of the statistical association in the stable model requires further validation through alternative specifications, coding checks, and appendix diagnostics.
RQ3: What do the stable model findings imply for MBG implementation?	The stable model identifies significant associations for environmental degradation, stunting-service provision, active KPM presence, facilitator presence, and poverty proxy, while governance readiness is not statistically significant.	The results suggest that implementation capacity and village vulnerability are multidimensional. No single readiness indicator is sufficient to explain expected burden on its own. Program interpretation should therefore rely on combined diagnostics rather than on one composite variable alone.	MBG should use a risk-informed approach that combines service readiness, local institutional support, and village vulnerability indicators, rather than relying solely on reported severe-case counts or on a single readiness index.
Additional operational finding	The stunting service package index and active KPM presence are negatively associated with expected event counts, while facilitator presence and poverty proxy are positively associated with expected counts.	Villages with broader service packages and active KPM support may be better positioned to reduce severe malnutrition burden. By contrast, higher expected counts in villages with facilitators or higher poverty may reflect greater underlying vulnerability, stronger case visibility, or both.	MBG operational planning should prioritize poor villages and should strengthen coordination between service packages, KPM support, and frontline implementation, while interpreting facilitator presence as a possible marker of higher-need contexts rather than as a simple capacity advantage.

Note: This matrix is based on the stable main negative binomial specification (NB_MAIN) and is intended to separate observed statistical results from cautious substantive interpretation.

For policy purposes, this means that targeting should combine village readiness indicators, poverty-related vulnerability, and environmental diagnostics. [Table 4](#) translates the main empirical findings into cautious analytical and policy conclusions, while [Table 5](#) converts these conclusions into a tiered operational framework.

3.6. Robustness and Diagnostic Notes

The main conclusions are anchored in the stable negative binomial specification because fuller count models showed convergence problems and collinearity in some controls. For this reason, supplementary comparisons such as Poisson or zero-inflated variants are best treated as appendix diagnostics rather than as substitutes for the main interpretation.

3.7. Answering the Research Questions

The study examined whether village governance readiness and environmental degradation are associated with severe malnutrition events and what these relationships imply for MBG implementation. The stable model does not provide strong evidence that governance readiness independently increases expected

burden, but it does support the broader view that implementation context matters for how cases are detected, recorded, and interpreted.

Environmental degradation remains substantively important, but the negative coefficient in the stable count model indicates that its statistical role should be interpreted cautiously rather than normatively. The result highlights the need for coding checks, alternative diagnostics, and caution against drawing overly simple causal conclusions.

More consistent signals emerge from service-package coverage, KPM presence, facilitator presence, and poverty proxy. These variables suggest that village burden is shaped by a combination of vulnerability and institutional capacity, which is directly relevant to MBG design.

Accordingly, the main policy lesson is not that any single variable explains severe malnutrition, but that MBG should be implemented through combined diagnostics of readiness, vulnerability, and local support conditions.

3.8. Why Detection and Burden Must Be Distinguished

One reviewer concern was that the previous manuscript implied interpretation without adequate explanation. Severe malnutrition is not automatically visible in village statistics. It depends on whether cadres, local services, and reporting routines are sufficiently active to identify, document, and transmit cases. This is why readiness-related variables may affect observed burden even when underlying pathology is unchanged (Djani et al., 2025; Pacetti et al., 2025; Yakubu et al., 2025).

This distinction matters for MBG because villages with lower readiness may appear to have fewer cases while actually experiencing under-detection. Reported burden should therefore be interpreted together with information on institutional readiness and service coverage.

3.9. Integrating Nutritional Risk, Service Readiness, and Environmental Context

The study also reinforces the need to integrate nutritional, environmental, and governance perspectives. Severe malnutrition risk is shaped not only by food access and health services but also by sanitation, water, waste-management, and pollution conditions that affect both households and local service environments (Budiono et al., 2024; Sojobi & Zayed, 2022).

At the same time, the statistical findings caution against reducing this relationship to a single directional coefficient. Environmental conditions remain operationally important for MBG, but they should be incorporated through risk screening and local assessment rather than simplistic assumptions.

3.10. Operational Implications for MBG

The clearest practical implication is that MBG should use a tiered implementation framework. High-risk villages with weak readiness require the most intensive support, including active case finding, closer referral coordination, additional cadre support, and stronger supervision. High-risk villages with stronger readiness can serve as sites for adaptive implementation and integrated monitoring. Villages with lower risk but weaker readiness need system strengthening before program intensification, whereas lower-risk, higher-readiness villages can proceed under routine monitoring.

This operational logic also highlights the importance of integrating health and environmental governance at village and district levels. Where sanitation and environmental risks are high, food provision alone is unlikely to be sufficient.

3.11. Implications, Limitations, and Appendix Use

The study links village governance and environmental conditions to severe malnutrition events in a manner directly relevant to program management, with the operational implications summarized in Table 5. Its main limitation is that some richer specifications were unstable; therefore, alternative count models and collinearity checks are best reported as supporting material rather than as the primary basis for inference.

Table 5. Result–Analysis–Conclusion Matrix for MBG Policy Interpretation

Governance Readiness	Environmental Risk	Priority Level	Operational Objective	Recommended Actions
Low	High	Very High	Prevent undetected severe malnutrition and major delivery failure	Intensive supervision, strengthened case finding, additional cadre training, closer referral linkage with puskesmas, environmental and sanitation risk screening, and district-level implementation assistance
High	High	High	Sustain detection capacity while adapting delivery to elevated local risk	Adaptive MBG delivery, integrated nutrition–environment monitoring, intensified child screening, rapid referral escalation, and cross-sector coordination between health and environmental actors
Low	Low	Moderate	Improve implementation readiness before program expansion	Administrative strengthening, reporting improvement, cadre mentoring, clarification of local implementation roles, and reinforcement of routine service delivery
High	Low	Routine	Maintain effective program delivery with efficient oversight	Standard MBG implementation, routine monitoring, periodic audit, and documentation of good practices for replication

3.12. Concluding Discussion

Overall, the results indicate that MBG effectiveness depends on more than food delivery. Expected severe-malnutrition burden reflects a combination of local vulnerability, service coverage, support structures, and case visibility. This supports a context-sensitive implementation strategy that combines readiness assessment, poverty screening, and environmental diagnosis.

By grounding interpretation in the stable model and translating the findings into a tiered operational framework, the manuscript provides a more cautious yet more policy-useful basis for strengthening MBG.

4. Conclusion

This study shows that severe malnutrition events can serve as operational indicators for strengthening MBG, but they should be interpreted together with village readiness, poverty-related vulnerability, service coverage, and environmental context. In the stable count model, governance readiness is not a statistically confirmed driver of expected burden, whereas stunting-service provision, KPM presence, facilitator presence, poverty proxy, and environmental conditions remain important for program interpretation.

MBG should adopt a tiered, risk-informed strategy rather than relying solely on reported case counts. Villages with weak readiness and high risk require intensive support, whereas stronger-readiness settings require adaptive monitoring and closer health-environment coordination.

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