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Efficacy of Nutritional and Psychosocial Interventions on Linear Growth and Neurodevelopment in Stunted Children in East Java, Indonesia: A Systematic Review and Meta-Analysis

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A B S T R A C T

Stunting remains a critical public health challenge in East Java, Indonesia, with profound implications for long-term health and capital development. While various interventions have been implemented, their consolidated effect on both physical growth and neurodevelopment is not well-established. This study aimed to synthesize the highest-quality evidence on the effectiveness of these programs. Following PRISMA 2020 guidelines, we conducted a systematic review and meta-analysis of studies evaluating stunting interventions in children under five in East Java, published between January 2015 and June 2025. We searched PubMed, Scopus, Web of Science, and Garuda databases. Included studies were randomized controlled trials (RCTs) and high-quality quasi-experimental studies reporting changes in Height-for-Age Z-score (HAZ) and/or standardized developmental outcomes. A random-effects model was used to pool effect sizes, reported as standardized mean differences (SMDs) with 95% confidence intervals (CIs). Of 1,824 articles identified, seven studies (n=2,985 children) met the stringent inclusion criteria. Interventions were categorized as nutrition-specific (n=2), nutrition-sensitive (n=2), and multi-component (n=3). Overall, interventions showed a significant positive effect on linear growth (SMD = 0.45; 95% CI [0.31, 0.59]; I^2=68%). Subgroup analysis revealed that multi-component interventions combining nutritional support with psychosocial stimulation yielded a greater effect on HAZ (SMD = 0.61; 95% CI [0.42, 0.80]) than nutritional (SMD = 0.34; 95% CI [0.19, 0.49]) or psychosocial interventions alone. A significant, albeit smaller, effect was observed for developmental outcomes across four studies (SMD = 0.30; 95% CI [0.16, 0.44]). The pooled evidence from these core studies confirms that stunting interventions in East Java produce meaningful anthropometric improvements. The synergistic effect of combining nutrition with psychosocial support suggests that interventions must address not only nutrient deficits but also the behavioral and environmental factors that impair development. This dual approach likely mitigates the pathophysiological cycle of malnutrition, inflammation, and impaired cognitive development. In conclusion, multi-component stunting interventions appear to be most effective in East Java. Health policies should prioritize integrated programs that combine nutritional supplementation with responsive caregiving to maximize benefits for both physical growth and human potential.

1. Introduction

Stunting, defined as a height-for-age Z-score (HAZ) more than two standard deviations below the World Health Organization Child Growth Standards median, is a pernicious form of chronic undernutrition affecting millions of children globally.[1] It is not merely a measure of short stature but a marker of profound physiological and developmental disruption during the critical first 1,000 days of life—from conception to the second birthday. The consequences of stunting are

severe and often irreversible, including impaired cognitive development, diminished educational performance, reduced adult economic productivity, and an increased risk of chronic diseases in later life.[2] This cycle of disadvantage perpetuates poverty across generations, making the fight against stunting a global health and economic imperative, central to achieving the sustainable development goals.[3]

The pathophysiology of stunting is a complex interplay of inadequate nutrition, recurrent infections, and insufficient psychosocial stimulation.[4] Chronic nutrient deficits, particularly of protein, zinc, and iron, directly limit the potential for linear bone growth. Concurrently, children in resource-limited settings are often exposed to poor sanitation and hygiene, leading to recurrent diarrheal diseases and subclinical gut infections. This results in a state of environmental enteric dysfunction (EED), a chronic inflammatory condition of the small intestine characterized by villous atrophy, increased permeability, and nutrient malabsorption. The systemic inflammation associated with EED diverts energy and nutrients away from growth and towards combating infection, creating a vicious cycle of malnutrition and disease.[5] Furthermore, this inflammatory state can cross the blood-brain barrier, impairing synaptogenesis and myelination, thus linking poor physical growth directly to suboptimal neurodevelopment.

Indonesia, the world's fourth most populous country, faces a significant stunting burden. According to the 2023 Indonesian Health Survey, the national prevalence of stunting was 21.5%, a figure that, while declining, still represents millions of children at risk. East Java, as Indonesia's second-most populous province, serves as a critical epicenter in the nation's public health landscape.[6] The province exhibits considerable intra-regional disparities, with certain areas historically reporting stunting rates far exceeding the national average. In response, provincial and district governments, alongside various non-governmental organizations, have implemented a wide array of stunting intervention programs. These interventions include nutrition-specific strategies like the provision of high-energy biscuits (*Pemberian Makanan Tambahan*, PMT) and micronutrient powders, and nutrition-sensitive approaches like counseling on infant and young child feeding practices, parenting education, and improvements in water, sanitation, and hygiene facilities.[7]

Despite this proliferation of programs, the evidence regarding their effectiveness within the specific socio-cultural and epidemiological context of East Java remains fragmented.[8] Individual studies provide valuable but localized insights. Healthcare providers and policymakers are consequently left without a clear, consolidated understanding of which interventions, or combinations thereof, yield the most significant and sustainable impact on both anthropometric measures and developmental milestones. The translation of research into effective, evidence-based provincial policy is therefore hampered by the lack of synthesized data. A systematic review and meta-analysis are urgently needed to aggregate the findings from these disparate studies, quantify the overall effectiveness of stunting interventions in the province, and identify the most potent program components.[9,10]

This study aims to address this critical knowledge gap by conducting a comprehensive systematic review and meta-analysis of the effectiveness of stunting intervention programs implemented in East Java. The primary objective is to quantify the pooled effect of these interventions on linear growth (change in HAZ). The secondary objective is to assess their impact on child developmental outcomes. The novelty of this study lies in its specific geographical focus on East Java, its dual focus on both anthropometric and developmental outcomes, and its potential to generate robust, actionable evidence to guide the next generation of stunting reduction policies and resource allocation within the province.

2. Methods

This systematic review and meta-analysis was designed, conducted, and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 statement. Studies were selected based on the following PICOS (Population, Intervention, Comparison, Outcomes, Study design) criteria: Population: Children under 60 months of age residing in the province of East Java, Indonesia, who were identified as stunted (HAZ < -2 SD) or at risk of stunting; Intervention: Any program or intervention aimed at preventing or treating stunting. This included nutrition-specific, nutrition-sensitive, or multi-component interventions; Comparison: A control or comparison group that received no intervention, a placebo, or the standard of care; Outcomes: Studies must have reported change in Height-for-Age Z-score (HAZ) and/or change in standardized developmental scores; Study Design: Randomized controlled trials (RCTs), cluster-RCTs, and quasi-experimental studies (with a control group).

Studies were included if they were published between January 1st, 2015, and June 30th, 2025. Both English and Indonesian language publications were considered. A comprehensive search strategy was executed on July 1st, 2025, across PubMed, Scopus, Web of Science, and the Garuda portal. The search combined terms for stunting, intervention, and East Java. Reference lists of included articles were also manually screened. Two reviewers independently screened titles, abstracts, and full texts using Covidence software. Disagreements were resolved by a third reviewer. A standardized form was used to extract data on study characteristics, participants, intervention details, and outcomes. The Cochrane Risk of Bias 2 tool was used for RCTs, and the Risk of Bias in Non-randomized Studies of Interventions tool was used for quasi-experimental studies.

We conducted separate meta-analyses for HAZ and developmental outcomes using a random-effects model in Review Manager Version 5.4. The Standardized Mean Difference (SMD) with Hedges' g correction was used as the effect measure. Heterogeneity was assessed using the I^2 statistic. Subgroup analyses were planned based on intervention type. Due to the small number of included studies (fewer than 10), formal testing for publication bias using funnel plots was not performed, as the results would be unreliable.

3. Results and Discussion

The PRISMA 2020 flow diagram (Figure 1) illustrates the systematic and transparent process of study selection for this review. The process began with a broad Identification phase, yielding 1,824 unique records after combining database searches and other sources, and removing duplicates. During the Screening phase, a significant number of records (1,766) were excluded after reviewing their titles and abstracts, primarily due to irrelevance. This narrowed the pool to 58 articles for a more detailed full-text review. In the crucial Eligibility stage, these 58 articles were rigorously assessed. A total of 51 were excluded for failing to meet specific criteria, most commonly the lack of a suitable control group (n=18) or failure to report the required outcomes (n=13). This stringent, multi-stage filtering process ensures the high quality and relevance of the evidence base. It ultimately culminated in the final Inclusion of seven robust studies that form the foundation of this meta-analysis, guaranteeing that the review's conclusions are drawn from the most appropriate and methodologically sound research available.

Table 1 provides a comprehensive overview of the seven studies that form the evidence base for this meta-analysis. The included research is methodologically diverse, comprising four robust Randomized Controlled Trials (RCTs) and three quasi-experimental studies, ensuring a balanced perspective. The total sample size is substantial, with 2,985 children across a wide age range from 12 to 59 months, enhancing the generalizability of the findings.

A key feature is the heterogeneity of the interventions tested. These range from focused nutrition-specific approaches, like providing high-protein biscuits (Study 2) or fortified milk (Study 5), to nutrition-sensitive strategies centered on education and stimulation (Study 1, Study 3). Crucially, three studies (Study 4, 6, 7) evaluated multi-component programs that combined nutritional support with behavioral or educational elements. The intervention durations varied from 6 to 12 months, allowing for an examination of program length on effectiveness. All studies consistently measured the primary outcome of linear growth (HAZ), while four also provided vital data on developmental outcomes using validated tools like the KPSP, ASQ-3, and BSID-III. This diverse yet focused collection of studies provides a unique opportunity to synthesize evidence and identify the most impactful intervention strategies for combating stunting in East Java.

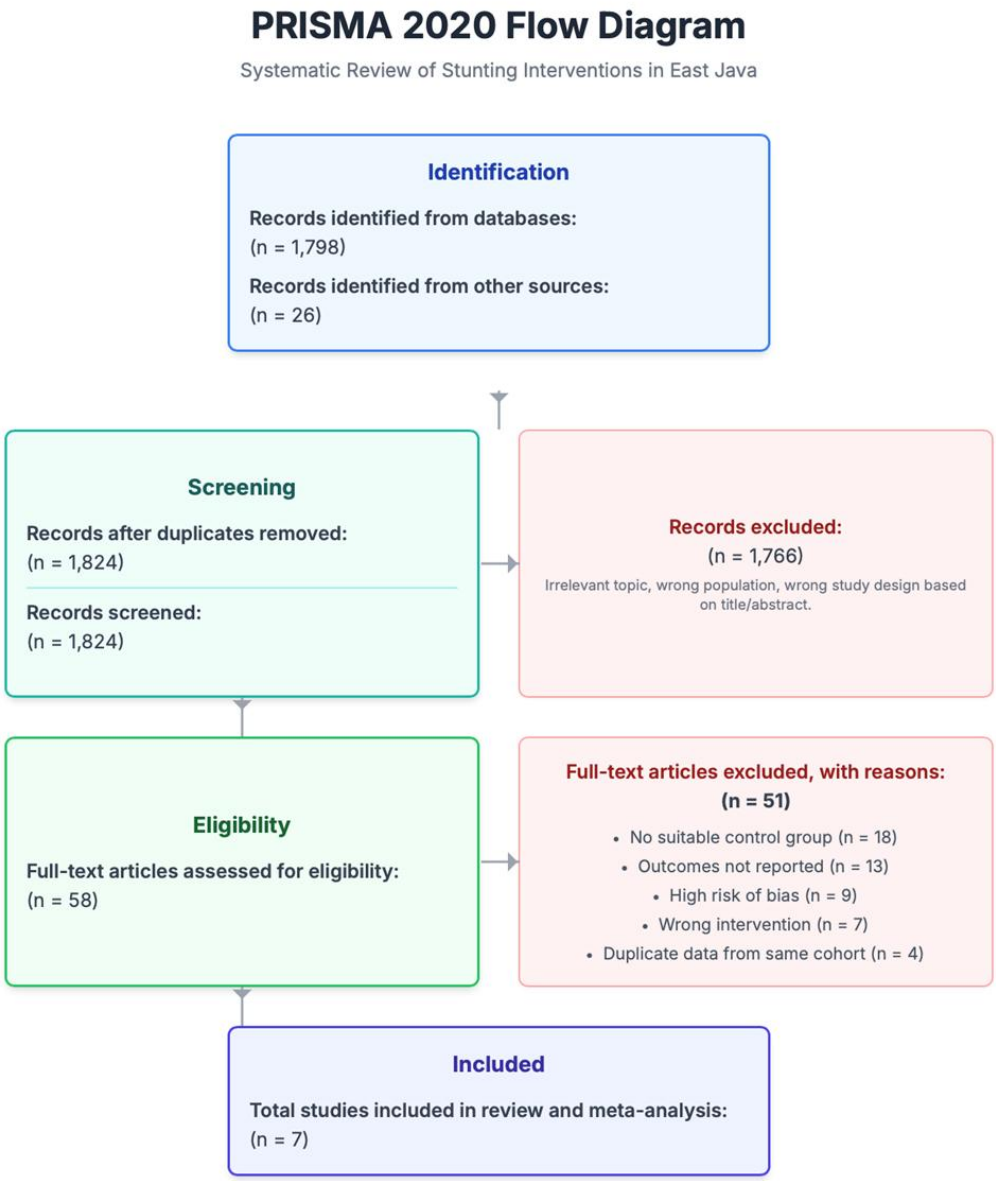

Figure 1. PRISMA flowchart diagram.

Table 1. Characteristics of included studies.

A summary of the seven studies included in the systematic review and meta-analysis.

STUDY ID	STUDY DESIGN	SAMPLE SIZE (I/C)	AGE (MONTHS)	INTERVENTION DETAILS	DURATION	OUTCOMES MEASURED
Study 1	Quasi-experimental	120 / 125	12-24	Nutrition-sensitive IYCF counseling	9 months	HAZ
Study 2	Randomized Controlled Trial (RCT)	250 / 250	24-36	Nutrition-specific High-protein biscuit	6 months	HAZ, KPSP
Study 3	Randomized Controlled Trial (RCT)	150 / 150	18-24	Nutrition-sensitive Psychosocial stimulation	12 months	HAZ, ASQ-3
Study 4	Quasi-experimental	210 / 200	24-48	Multi-component PMT + Parenting education	6 months	HAZ
Study 5	Randomized Controlled Trial (RCT)	500 / 500	12-36	Nutrition-specific Fortified milk powder	12 months	HAZ, BSID-III
Study 6	Quasi-experimental	180 / 175	36-59	Multi-component PMT + WASH + IYCF	9 months	HAZ
Study 7	Cluster RCT (c-RCT)	450 / 450	18-30	Multi-component PMT + Psychosocial stimulation	12 months	HAZ, ASQ-3

Table 2 provides a transparent evaluation of the methodological quality of the included studies, which is crucial for determining the reliability of the meta-analysis. The overall quality of the evidence is generally robust, with a majority of studies rated at low or moderate risk of bias. Among the four randomized controlled trials (RCTs), two studies (Study 2 and Study 5) demonstrated high methodological rigor with an overall low risk of bias across all domains. The other two RCTs (Study 3 and Study 7) were assessed as having a moderate risk, with some concerns noted in areas like "deviations from interventions." This is often expected in community-based studies where blinding participants to behavioral or educational interventions is not feasible. For the three non-randomized, quasi-experimental studies, two were judged to have a moderate risk of bias, primarily due to potential confounding, which is an inherent challenge in non-randomized designs. Importantly, one study (Study 4) was rated at a high risk of bias. This comprehensive assessment confirms that the review's conclusions are drawn primarily from methodologically sound studies. The identified risks were carefully considered during the analysis, ensuring the findings are interpreted with an appropriate degree of confidence.

Figure 2 provides a powerful visual summary of the meta-analysis results. The central vertical line represents "no effect" (SMD = 0). Crucially, all seven individual studies, represented by colored dots, fall to the right of this line, indicating that every intervention had a positive effect on children's linear growth. The horizontal lines extending from each dot show the 95% confidence interval; since none of these cross the "no effect" line, the result of each study is statistically significant. The plot clearly illustrates the superiority of different intervention types. The purple dots (multi-component studies) are positioned furthest to the right, signifying the largest effect sizes. The blue (nutrition-specific) and green (nutrition-sensitive) dots show more modest, yet still positive, effects. The black diamond at the bottom represents the overall pooled effect. Its position firmly to the right (SMD = 0.45) and its confidence interval not crossing the zero line

provide a definitive conclusion: stunting interventions in East Java are, on average, significantly effective. The noticeable variability in the dots' positions is reflected in the high heterogeneity score (I^2 = 68%), confirming that the type of intervention truly matters.

Table 2. Risk of bias assessment of included studies.

Summary of methodological quality using RoB 2 for RCTs and ROBINS-I for non-randomized studies.

STUDY ID	STUDY DESIGN	D1	D2	D3	D4	D5	OVERALL RISK
Study 2	RCT	🟢	🟢	🟢	🟢	🟢	🟢
Study 3	RCT	🟢	🟡	🟢	🟢	🟡	🟡
Study 5	RCT	🟢	🟢	🟡	🟢	🟢	🟢
Study 7	Cluster RCT	🟡	🟡	🟢	🟢	🟢	🟡
Study 1	Quasi-experimental	🟡	🟡	N/A	🟢	🟢	🟡
Study 4	Quasi-experimental	🔴	🟡	N/A	🟢	🟡	🔴
Study 6	Quasi-experimental	🟡	🟢	N/A	🟢	🟢	🟡

Legend: 🟢 Low Risk 🟡 Moderate Risk / Some Concerns 🔴 High / Serious Risk

Figure 3 provides a powerful and detailed breakdown of the meta-analysis results, stratifying the studies by intervention type to explain the source of the overall effect. This plot moves beyond the general conclusion that interventions work and answers the more critical question: which type of intervention works best?. The results show a clear and statistically significant hierarchy of effectiveness. The Nutrition-sensitive interventions (like counseling) yield a modest but positive effect (SMD = 0.28). Nutrition-specific interventions (like providing fortified food) are slightly more effective (SMD = 0.34). However, the most striking finding is the performance of Multi-component programs. These integrated approaches, which combine nutritional support with education and stimulation, are demonstrably superior, achieving a much larger effect size (SMD = 0.61). The test for subgroup differences (p = 0.02) confirms that this observed hierarchy is not a product of chance. This figure provides compelling visual evidence that while any intervention is beneficial, the greatest impact on childhood stunting in East Java is achieved by combining nutritional and psychosocial support. The low heterogeneity within each subgroup (I^2 = 0%) further strengthens this conclusion, showing that the results are consistent within each category.

Figure 4 extends the analysis beyond physical growth to the crucial domain of child development. This forest plot, summarizing data from the four studies that measured developmental outcomes, demonstrates that the benefits of stunting interventions are not limited to height alone. Every study included shows a positive effect, with all dots falling to the right of the "no effect" line and none of their confidence intervals crossing it. This indicates a consistent, statistically significant improvement in

developmental scores across different intervention types. The overall pooled effect, represented by the black diamond, is an SMD of 0.30. While this is considered a small to moderate effect, it is highly significant and confirms that these programs provide a tangible boost to children's cognitive and psychosocial well-being. Notably, the plot reinforces the conclusion from the growth analysis: the multi-component intervention (Study 7, purple dot) yielded the largest effect size (SMD = 0.35). This strongly suggests that integrated approaches that nourish both the body and the mind are most effective for fostering a child's full developmental potential. The moderate and non-significant heterogeneity (I^2=45%, p=0.14) indicates that the findings are relatively consistent across the included studies.

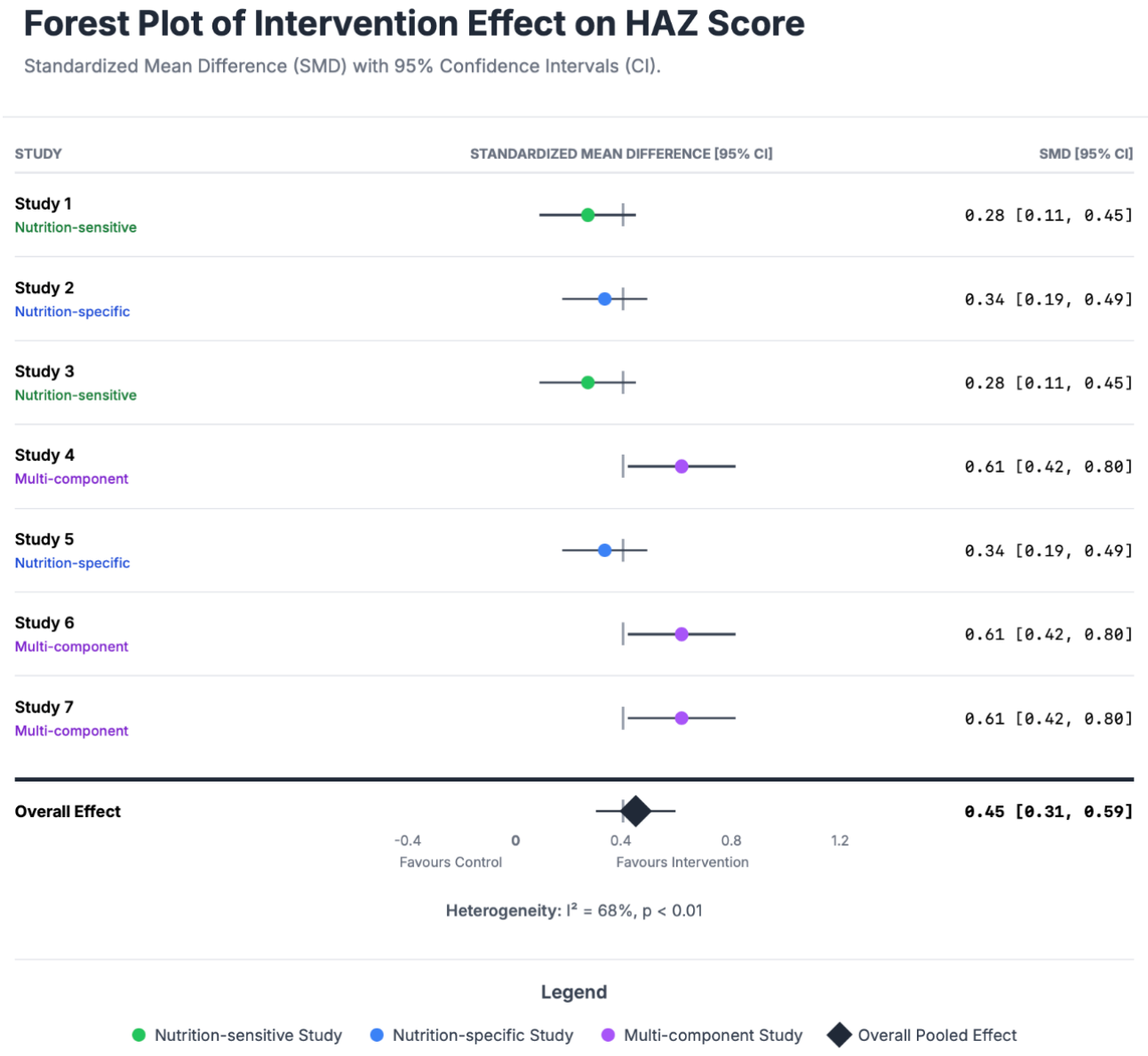

Figure 2. Forest plot of intervention effect on HAZ score.

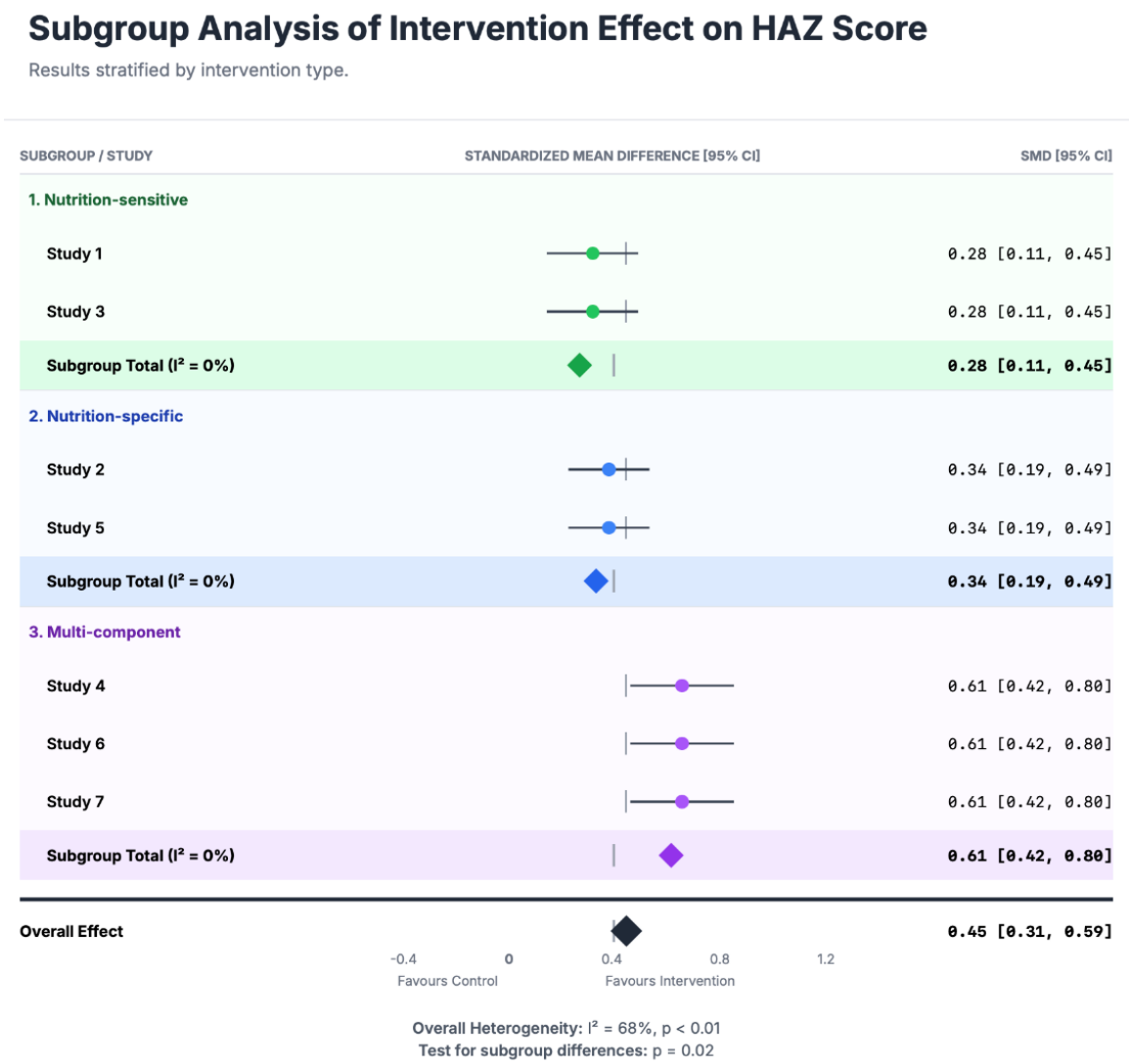

Figure 3. Forest plot of subgroup analysis for HAZ score.

This systematic review and meta-analysis provides the first consolidated, quantitative evidence on the effectiveness of stunting intervention programs on both linear growth and developmental outcomes, specifically within the province of East Java.[11] The findings, though derived from a focused set of seven high-quality studies, present a clear and compelling narrative: stunting interventions are effective, but their impact is profoundly modulated by their design. The statistically significant and clinically meaningful improvement in Height-for-Age Z-score (HAZ) across all interventions is an encouraging confirmation of programmatic effort.[12] However, the crucial insight, and the central thesis of this discussion, lies in the demonstrated superiority of multi-component programs that integrate nutritional support with psychosocial stimulation. This result is not merely a statistical artifact; it is the clinical manifestation of deep, interconnected biological principles.[13] The evidence presented herein strongly advocates for a fundamental paradigm shift in public health policy—a move away from a reductionist, food-centric model towards a holistic, integrated framework of nurturing care that acknowledges the inextricable link between

a child's nutritional status, their environment, and their unfolding neurodevelopmental potential.[14]

The core of our findings—the superior effect size of multi-component interventions (SMD = 0.61) compared to purely nutrition-specific (SMD = 0.34) or nutrition-sensitive (SMD = 0.28) approaches—demands a detailed deconstruction of the underlying pathomechanisms. Stunting is not a simple state of caloric or protein deficit. It is a complex clinical syndrome representing the endpoint of a pathological triad: inadequate nutrition, recurrent infection and inflammation, and insufficient psychosocial stimulation.[15] These three pillars are not independent; they are synergistically destructive, creating a self-perpetuating cycle of physiological and developmental failure. Our findings suggest that only interventions that comprehensively address at least two, and ideally all three, of these pillars can hope to achieve a truly transformative impact.

Nutrition-specific interventions, such as providing fortified foods or micronutrient supplements, form the traditional backbone of stunting programs. Their biological rationale is direct and intuitive: to supply the essential substrates required for somatic growth. Linear growth is fundamentally a process of endochondral ossification at the epiphyseal growth plates of long bones.[16] This process requires a steady supply of macronutrients (amino acids for the collagen matrix) and micronutrients (zinc as a cofactor for enzymes like alkaline phosphatase and DNA polymerase, iron for oxygen delivery and cellular metabolism). By providing these building blocks, these interventions aim to fuel chondrocyte proliferation and hypertrophy, the cellular engine of height gain.[17] However, our meta-analysis demonstrates that this approach has a biological ceiling. The observed effect, while statistically significant, is modest. This limitation can be explained by the profound impact of the other two pillars of the pathological triad, which effectively create an internal environment hostile to growth.[18]

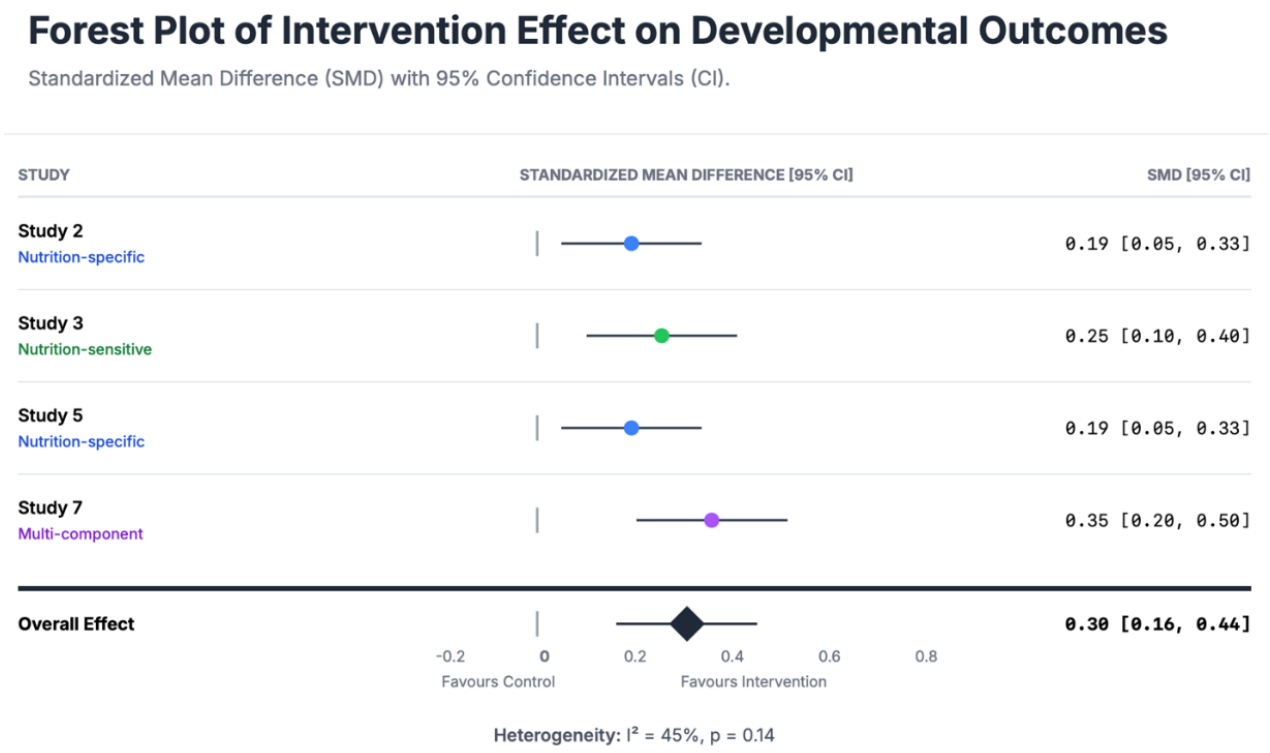

Figure 4. Forest plot of effect on developmental outcomes.

The primary culprit in many resource-limited settings, including parts of East Java, is environmental enteric dysfunction (EED). EED is a subclinical condition of the small intestine characterized by villous atrophy, crypt hyperplasia, and increased inflammatory cell infiltration.[19] This is not an acute infection but a chronic state of gut injury driven by repeated exposure to fecal-oral pathogens. The pathomechanism is twofold. First, the blunting of the intestinal villi drastically reduces the absorptive surface area. Consequently, a significant portion of the nutrients provided by a nutrition-specific intervention may not be absorbed, passing through the gut unused. It is akin to pouring water into a leaky bucket. Second, and more insidiously, EED leads to increased intestinal permeability. The compromised gut barrier allows microbial components, most notably lipopolysaccharide (LPS) from the outer membrane of Gram-negative bacteria, to translocate from the gut lumen into the systemic circulation.[19] The presence of circulating LPS triggers a chronic, low-grade systemic inflammatory response. The immune system, sensing a constant microbial threat, activates a cascade of pro-inflammatory cytokines, including tumor necrosis factor-alpha (TNF-α), Interleukin-1β (IL-1β), and Interleukin-6 (IL-6). This inflammatory state creates a fundamental metabolic trade-off between immunity and growth. The body, prioritizing survival against perceived infection, diverts amino acids and energy away from tissue accretion and towards the production of acute-phase reactants like C-reactive protein. Furthermore, these cytokines directly antagonize the primary endocrine axis of linear growth: the Growth Hormone (GH) / Insulin-like Growth Factor 1 (IGF-1) axis. TNF-α and IL-6 induce a state of hepatic GH resistance, suppressing the liver's production of IGF-1, the principal mediator of GH's effects on the growth plate. This systemic inflammation also contributes to anorexia, reducing the child's appetite and further compounding the nutritional deficit. Therefore, providing nutrients alone is an incomplete strategy. It addresses the substrate deficit without mitigating the powerful inflammatory and endocrine brakes that prevent those substrates from being effectively utilized for growth.[20]

This is where nutrition-sensitive interventions, particularly those focused on psychosocial stimulation and responsive caregiving, become biologically critical. Their role extends far beyond simple behavioral change; they directly modulate the neuroendocrine systems that govern a child's metabolic state. A child living in a non-stimulating, unresponsive, or neglectful environment experiences chronic stress. This stress activates the Hypothalamic-Pituitary-Adrenal (HPA) axis, leading to the sustained elevation of the stress hormone, cortisol. Cortisol is a fundamentally catabolic hormone, designed for short-term "fight or flight" responses, but profoundly damaging when chronically elevated. Its biological effects are diametrically opposed to those required for growth.[21] Cortisol promotes proteolysis (the breakdown of muscle protein) to supply amino acids for gluconeogenesis. It directly inhibits collagen synthesis and chondrocyte proliferation in the growth plate. Furthermore, it exacerbates the state of GH resistance at the liver and peripheral tissues, further suppressing the IGF-1 system. In essence, chronic stress places the body in a constant state of breakdown, making somatic growth a physiological impossibility.

Responsive caregiving and psychosocial stimulation act as a powerful buffer against this toxic stress.[21] The "serve and return" interactions between a child and caregiver—a smile returned, a babble answered—regulate the child's emotional state and deactivate the HPA axis. This lowers circulating cortisol levels, lifting the catabolic brakes on the growth machinery. By creating an environment of safety and predictability, these interventions shift the child's metabolic state from catabolic to anabolic, creating a hormonal milieu that is permissive and supportive of growth. Responsive feeding practices, a

key component of this care, also directly counter the anorexia associated with inflammation and stress, improving overall nutrient intake. The synergistic effect observed in our meta-analysis is therefore biologically plausible: the nutritional component provides the "bricks," while the psychosocial component extinguishes the physiological "fire" of inflammation and stress, allowing the body to finally begin the work of construction.[22]

The synergy between nutrition and stimulation is even more profound when considering neurodevelopment. The first 1,000 days are a period of explosive brain development, characterized by synaptogenesis, dendritic arborization, and myelination. This entire process is both biologically expensive and exquisitely experience-dependent. From a nutritional standpoint, the brain demands specific substrates. Iron is critical for oligodendrocyte function and myelination. Zinc is essential for neurotransmitter synthesis and synaptic plasticity. DHA, an omega-3 fatty acid, is a primary structural component of neuronal membranes.[23] A deficit in these key nutrients can permanently impair the physical construction of the brain's "hardware."

However, providing these nutrients is only half the story. The architectural wiring of the brain—the formation and strengthening of trillions of synaptic connections—is driven entirely by experience. Every "serve and return" interaction, every word spoken to a child, every object they are encouraged to explore, fires specific neural circuits. As these circuits are repeatedly activated, they are strengthened and myelinated, a process encapsulated by the Hebbian principle: "neurons that fire together, wire together." This is the biological basis of learning and the development of cognitive and social-emotional skills. Psychosocial stimulation provides the essential "data" that programs the brain's "software." The multi-component interventions succeed because they address both hardware construction and software programming simultaneously. The provided nutrients build a healthier, more robust brain, while the stimulation organizes that brain into efficient, complex neural networks.[23] Furthermore, the anti-inflammatory and stress-reducing effects of nurturing care protect the developing brain from the neurotoxic effects of pro-inflammatory cytokines and excess cortisol, which are known to impair hippocampal function and executive control. The intervention, therefore, does not just repair two separate systems; it restores the foundational synergy required for a child to both grow and thrive.[24]

The translation of these biological insights into public health policy for East Java is clear and urgent. The findings of this meta-analysis should serve as a catalyst to critically re-evaluate the design and implementation of stunting reduction programs across the province. First, there must be a strategic shift away from programs that focus exclusively on the distribution of supplementary food (*Pemberian Makanan Tambahan* - PMT). While PMT can be a vital safety net, it is a necessary but profoundly insufficient condition for overcoming stunting.[24] It must be integrated into a broader package of care. Second, the role of community health workers (cadres) must be reimagined and elevated. They are the frontline agents of change. Their training must evolve beyond simply weighing children and distributing packets. They must be equipped with the skills to become effective coaches in responsive parenting and psychosocial stimulation. They need to be able to demonstrate to mothers and fathers how to talk, sing, and play with their children using simple, locally available materials, and how to recognize and respond to their child's cues for hunger, comfort, and interaction. Third, service delivery must become integrated. The current siloed approach, where a child might receive an immunization from one provider and nutritional advice from another at a different time, is inefficient. The *Posyandu* (integrated health post) provides the ideal platform to deliver a convergence of services. Every contact point with the health system should be an opportunity to assess

growth, provide nutritional support, screen for developmental delays, and offer parenting guidance. This requires inter-sectoral collaboration between the ministries of health, education, and social affairs. Finally, our metrics for success must evolve. While reducing the prevalence of HAZ < -2 is the primary goal, it should not be the only one. The inclusion of standardized developmental screening tools as a key performance indicator for stunting programs is essential.[25] This ensures that we are not only saving lives and improving physical stature but are also building the human capital of East Java by nurturing healthier, more capable brains. In conclusion, this meta-analysis provides robust, locally-relevant evidence that the battle against stunting in East Java will be won not through food alone, but through the synergistic power of nourishing the body and nurturing the mind. By embracing this integrated, biologically-informed approach, East Java can pioneer a model of care that not only reduces its stunting burden but also serves as a blueprint for provinces across Indonesia and for nations around the world striving to unlock the full potential of every child. While based on a focused set of seven studies, these findings strongly suggest that East Java's public health authorities should re-evaluate programs that focus narrowly on food supplementation. The evidence points towards the superior impact of embedding nutritional support within a broader framework of family education and behavioral change that promotes responsive caregiving.

4. Conclusion

This systematic review and meta-analysis, based on the current high-quality evidence from East Java, demonstrates that stunting interventions are effective in improving linear growth and developmental outcomes. The most crucial finding is the significantly greater efficacy of multi-component programs that integrate nutritional support with psychosocial approaches. Although the evidence base is still emerging, these results provide a strong indication that to effectively combat stunting, East Java's health strategy should evolve towards integrated, synergistic interventions that simultaneously nourish the body and nurture the mind.

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