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Effectiveness of Maranti Stimulation in Improving Growth and Development Among Stunted Toddlers: A Quasi-Experimental Study

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ABSTRACT

Introduction: Stunting remains a major public health concern in Indonesia, particularly during the first 1,000 days of life, and reflects the cumulative effects of nutritional deficits, infection, and suboptimal caregiving within broader social and environmental conditions. This study draws on current national and global evidence to frame stunting as a developmental and ecological problem that requires integrated, family-centred interventions. This study aimed to assess the effectiveness of Maranti stimulation (massage therapy for stunting), in enhancing growth and development among stunted children.

Methods: This quasi-experimental study utilized a non-equivalent control group design and was conducted from August to November 2024 at two public health centers in Bantul, Yogyakarta, Indonesia. Participants were divided into two groups: the intervention group (n=23), which received weekly Maranti massage sessions over six weeks, and the control group (n=25), which was provided with educational booklets on child growth and developmental stimulation. Growth measurements were collected using anthropometric tools, and developmental outcomes were assessed using the BSID-III instrument. Data normality was assessed prior to analysis. Normally distributed variables were analyzed using independent t-tests, while non-normally distributed variables were analyzed using the Mann–Whitney U test in Stata.

Results: The findings revealed significant improvements in growth and development post-intervention in both groups, with more pronounced effects in the intervention group. Notably, Maranti therapy significantly increased body weight (p=0.016) and height (p=0.001). Language (p=0.025) and motor skills (p=0.045) also improved significantly. Cognitive development, however, did not show a statistically significant change (p=0.635). Effect size analysis indicated medium to strong effects for weight and height (Cohen's d = 0.724 and 1.041), and moderate effects for language and motor development (Cohen's d = 0.580 and 0.595).

Conclusion: Maranti stimulation demonstrates promise as an effective complementary strategy to improve physical growth and developmental outcomes in stunted children, though further research is needed regarding cognitive impacts. These findings suggest that culturally embedded tactile stimulation can serve as a feasible complementary approach for growth-promotion programs. The intervention holds potential for integration into community-based stunting-reduction strategies, particularly in settings where traditional practices remain influential.

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INTRODUCTION

Stunting is a chronic nutritional disorder in children under five, defined by a height-for-age z-score below -2 standard deviations (SD) from the World Health Organization (WHO) child growth standards median (1). It represents a major public health concern, contributing to long-term health complications, reduced educational attainment, and lower economic productivity (2,3).

According to WHO data from 2017, Indonesia ranked third in stunting prevalence among Southeast Asian nations. The national prevalence declined from 24.4% in 2021 to 21.6% in 2022, as reported by the 2022 Indonesian Nutrition Status Survey. However, this rate remains well above the national target of 14% by 2024. In Yogyakarta, stunting prevalence decreased from 12.37% in 2018 to 10.69% in 2019 but slightly increased to 11.08% in 2020. This synthesis elucidates the multifaceted conceptual framework of stunting, which incorporates distal determinants (socioeconomic and regional factors) alongside proximal determinants (maternal nutrition and fetal assessments) that interact in a complex manner, underscoring the critical need for the implementation of evidence-based risk assessment methodologies in antenatal care to facilitate early intervention and mitigate fluctuations in prevalence. Prior investigations have shown that stunting has long-term consequences for the growth and development of children, including cognitive advancement, academic performance, reduced economic productivity in adulthood, and deleterious effects on maternal reproductive health (4).

Evidence suggests that stunting significantly increases the risk of future metabolic and degenerative conditions (5,6). In the short term, it affects brain development, impairs cognition, and disrupts physical growth and metabolism (7–9). Perkins et al (10) found that nearly 40% of children under five experience compromised developmental potential, with stunting being a leading contributing factor. Long-term impacts include reduced physical and intellectual function, delayed motor and cognitive development, poor academic performance, diminished adult productivity, and negative consequences for maternal reproductive health (11–13).

Within this developmental and ecological perspective, interventions that combine responsive caregiving, early stimulation, and culturally grounded touch practices such as Maranti massage are crucial to support growth and neurodevelopment in stunted children. Stunting prevention measures must incorporate cultural competency, encourage community involvement, and facilitate polite behavioral modification (14). Efforts to accelerate stunting reduction include optimizing growth and development through targeted stimulation. One such method is massage therapy, which has been shown to stimulate growth hormone production and increase serotonin levels—both of which support development (15). Positive tactile stimulation through baby spa massage has been linked to improved neural development in infants (16). Campbell & Jacobs identified a positive association between massage frequency and infants' socio-emotional development (17).

Parental massage interventions can enhance sensory-motor integration and physical development, particularly in premature infants (18). Sutarmi et al (19) reported that "healthy massage" improves anthropometric and personal-social development in infants aged 0–3 months. Massage therapy also activates the parasympathetic nervous system, which can promote weight gain and developmental progress in children under five (20,21). Furthermore, physical activity-based stimulation has shown cognitive benefits in populations with nutritional deficits (22).

Although the benefits of massage therapy on stunted children have been demonstrated in various studies, research within the Indonesian context remains limited. Additionally, unlike typical child massage, Maranti stimulation combines rhythmic pressure, warm oil friction, and culturally significant caregiver-child interaction. This can affect growth and development by increasing vagal activation, leading to better digestion and nutrient absorption, improved peripheral circulation supporting musculoskeletal development, and strengthened psychosocial bonds that reduce stress-related cortisol levels. This combination distinguishes Maranti from standard massage therapy and provides a new theoretical basis for understanding its potential impact on stunting. Therefore, this study aims to evaluate the effectiveness of Maranti stimulation (massage therapy for stunting) in improving growth and developmental outcomes among stunted children in Yogyakarta, Indonesia.

METHOD

Study Design

This quasi-experimental study employed a non-equivalent control group design to assess the impact of Maranti stimulation (massage therapy) on the growth and development of stunted children under five years old. The primary outcomes included physical growth (weight and height) and developmental domains (cognitive, language, and motor skills), measured before and after the intervention.

Population and Sample/Informants

The study population consisted of stunted children under five years old from two public health centers in Bantul Regency, Yogyakarta, Indonesia. The intervention group was drawn from Banguntapan 2 Health Center, which had a total of 216 stunted children, while the control group came from Sewon 2 Health Center, with 127 stunted children. Sample size was calculated using the formula for comparing two means, based on data from a previous study (23), with a 5% level of significance ($\alpha = 0.05$), power of 90% ($\beta = 0.10$), a mean difference of 10.7, and a standard deviation of 11.12. This yielded a minimum requirement of 23 participants per group. Participants were selected using purposive sampling. Inclusion criteria included stunted children aged 34 months or younger at pretest, parental consent for full participation, the absence of chronic illness, and did not receive therapeutic intervention for stunting complications in the hospital. A total of 50 children were initially enrolled; however, two participants from the intervention group withdrew, resulting in a final sample of 48 children (23 in the intervention group and 25 in the control group).

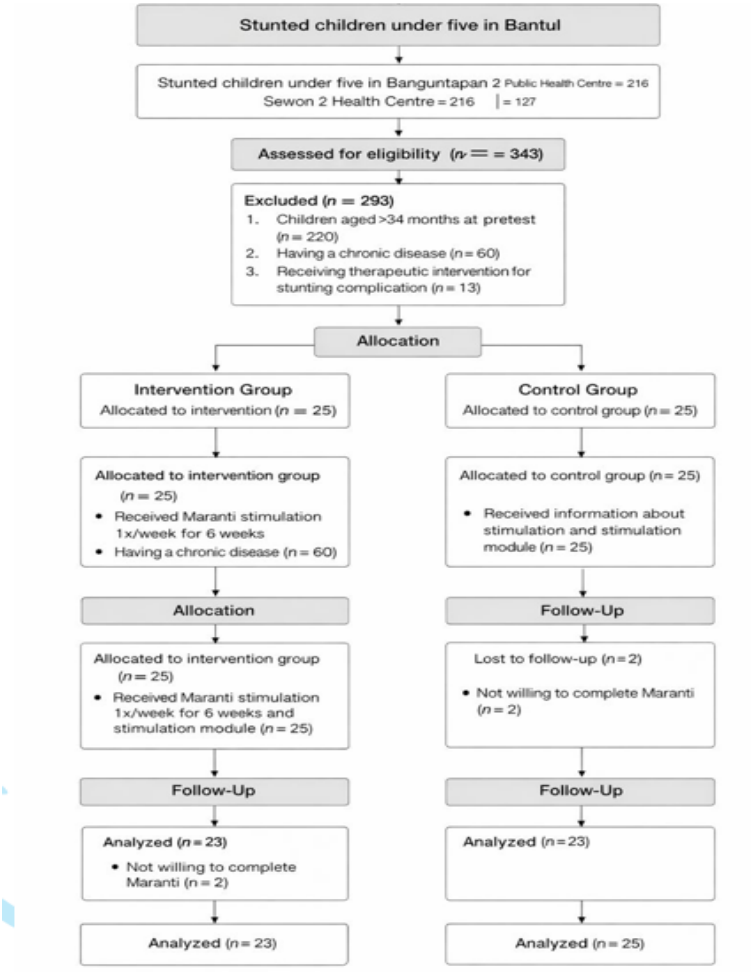

Figure 1. The process of respondents' selection

Research Location

The study was conducted at Banguntapan 2 and Sewon 2 Health Centers in Bantul Regency, Yogyakarta. These locations were purposefully selected due to their relatively high prevalence of childhood stunting, making them suitable settings for examining the effects of the intervention on growth and development outcomes.

Instrumentation or Tools

Growth measurements were obtained using standardized anthropometric tools operated by the main researcher with the assistance of trained enumerators. Child development was assessed using the Bayley Scales of Infant and Toddler Development, Third Edition (BSID-III), a validated tool widely used for identifying delays in cognitive, language, and motor development. BSID-III assessments were conducted by certified professionals to ensure the reliability and validity of the developmental measurements.

Data Collection Procedures

Data were collected before and after the intervention at the health centers, during scheduled visits with participating families. The intervention group received Maranti massage therapy, delivered once a week for six consecutive weeks by trained massage therapists in participants' homes. Meanwhile, the control group received a standardized educational booklet on child growth and development during the pre-test phase. Throughout the study, trained personnel conducted anthropometric assessments and development evaluations using a standardized protocol to maintain consistency.

Data Analysis

Quantitative analysis was conducted using independent t-tests to compare post-intervention differences between groups and paired t-tests to assess within-group changes performed in Stata 15.1. Prior to testing, data were evaluated for normality and homogeneity. To evaluate the strength of the intervention effects, Cohen's d was used as the effect size indicator and was calculated as the difference between the intervention and control group means divided by the pooled standard deviation. The pooled standard deviation was derived from both groups' variances. Effect size directionality was defined a priori, with positive values indicating greater post-intervention improvements in the intervention group. All statistical procedures aimed to determine the effectiveness of Maranti massage therapy on improving growth and developmental indicators in stunted children.

Ethical Approval

This study received ethical approval from the Aisyiyah University Yogyakarta Research Ethics Committee, with approval number 3951/KEP-UNISA/VIII/2024. Ethical standards were strictly upheld throughout the research process, including obtaining informed consent from all parents or guardians, maintaining participant anonymity and data confidentiality, and ensuring that the principle of beneficence was applied at every stage of the study.

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RESULTS

The characteristics of respondents in both the intervention and control groups were generally homogeneous ($p > 0.05$), except for maternal education level and gestational age at birth, which demonstrated statistically significant differences.

Table 1. Frequency distribution of child's age, child's gender, maternal education, maternal employment, and maternal age

Maternal Characteristics	Group				*p*
	Intervention		Control		
	F	%	F	%	
Child's age group					
12-18 months	2	8.7	2	8.3	0.546
19-24 months	2	8.7	5	20.0	
25-30 months	8	34.8	6	24.0	
31-36 months	11	47.8	12	48.0	

Child's gender					
Male	13	56.5	16	64.0	0.335
Female	10	43.5	9	36.0	
Maternal education					
Elementary School	3	13.0	1	4.0	0.005
JHS	6	26.1	1	4.0	
SHS	5	21.7	15	60.0	
College	9	39.1	8	32.0	
Maternal employment					
Employed	11	47.8	13	52.0	0.981
Unemployed	12	52.2	12	48.0	
Maternal age					
20-35 years	12	52.5	15	60.0	0.376
<20 & >35 tahun	11	47.8	10	40.0	
Type of Labor					
Vaginal	14	60.9	15	60,4	0.905
SC	9	39.1	10	39.6	
Gestational Age					
Mature	18	78.3	24	87.5	0.000
Premature	5	21.7	1	12.5	
Maternal Knowledge					
Good	8	34.8	15	60.0	0.169
Fair	15	65.2	9	36.0	
Deficient	0	0.0	1	4.0	

Table 1 presents the baseline characteristics of respondents in both groups. Most children were aged 31–36 months, and boys predominated in both groups; neither variable differed significantly between groups ($p > 0.05$). Maternal education differed significantly ($p < 0.05$), with a higher proportion of mothers in the control group having secondary education and a higher proportion in the intervention group having tertiary education. Maternal age and employment status were comparable between groups ($p > 0.05$). Gestational age also differed significantly ($p < 0.05$), with a greater proportion of full-term births in the control group. Maternal knowledge did not differ significantly between groups ($p > 0.05$). Overall, the two groups were largely comparable, except for maternal education and gestational age, indicating the need for analytic adjustment to address potential confounding and ensure valid causal inference.

Data Normality Test Results

Table 2 presents the results of the Shapiro–Wilk normality test for growth variables (body weight and height) and developmental outcomes (cognitive, language, and motor domains). Data are stratified by study group (intervention and control) and measurement time point (pretest and posttest).

Table 2. Normality test results of Maranti stimulation data on growth and development of children in intervention and control groups

Variable	Groups	Pretest		Posttest	
		n	p	n	p
Growth					
Body Weight	Intervention	23	0.453	23	0.828
	Control	25	0.033	25	0.003
Body Height	Intervention	23	0.342	23	0.098
	Control	25	0.070	25	0.041
Development					
Cognitive	Intervention	23	0.077	23	0.779
	Control	25	0.984	25	0.649

Variable	Groups	Pretest		Posttest	
		n	p	n	p
Language	Intervention	23	0.832	23	0.784
	Control	25	0.744	25	0.346
Motoric	Intervention	23	0.742	23	0.709
	Control	25	0.429	25	0.064

Notes: The Shapiro–Wilk test was used to assess data normality. A p-value > 0.05 indicates a normal distribution, whereas a p-value ≤ 0.05 indicates a non-normal distribution. The results of this test were used to determine the selection of appropriate parametric or non-parametric statistical tests for subsequent analyses

The Shapiro-Wilk test revealed varying data distributions between groups and tests. Body weight was normally distributed in the intervention group but abnormal in the control group, with a significant difference. Body height was normal in the intervention group pretest but not posttest, while the control group showed inconsistent distributions, also with significant differences. Cognitive development data were mostly normal but differed significantly between groups. Language and motor development were generally normal in both groups, with no significant differences, indicating consistent distributions.

Homogeneity test of data on growth and development variables of children under five

A homogeneity test was performed to ensure equal variances for the growth and development variables of children under five before statistical analysis.

Table 3. Homogeneity test results of Maranti Stimulation data on growth of children under five in intervention and control groups

Variables	Intervention *Mean* [SD]	Control *Mean* [SD]	*p-value*
Growth			
Body Weight	10.1 [1.31]	9.8 [1.55]	0.252
Height	82.8 [3.99]	82.0 [5.55]	0.293
Development			
Cognitive	98.3 [13.95]	98.8 [14.1]	0.552
Language	93.5 [14.6]	97.7 [13.2]	0.852
Motor	96.2 [13.2]	96.2 [14.3]	0.499

Note: Data are presented as mean ± SD. Group homogeneity was assessed using independent t-tests or the Mann–Whitney U test, as appropriate. Statistical significance was set at $p < 0.05$

The homogeneity test showed similar growth and development data between groups (p > 0.05), confirming comparable baseline characteristics. Therefore, paired and independent t-tests were used for analysis to suit the data's properties.

Analysis of the Effect Test on Intervention Group and Control Group

Table 4 presents the results of the effect test comparing pretest and posttest outcomes within the intervention and control groups. Changes in body weight, body height, and developmental outcomes (cognitive, language, and motor) among children under five were evaluated to assess the effectiveness of the intervention.

Table 4. Results of Growth in Weight, Height, and Development of Cognitive, Language, and Motor Aspects in Children under Five

Variables		*t* | *z*	df	*P*
Children under Five Body Weight				
Intervention Group[a]	*Pretest-Posttest*	-6.7	-0.3	0.000
Control Group[b]	*Pretest-Posttest*	-2.2	-0.1	0.040
Children under Five Body Height				
Intervention Group[a]	*Pretest-Posttest*	-7.2	-1,0	0.000
Control Group[b]	*Pretest-Posttest*	-6.2	-0.4	0.000

Variables		*t* | *z*	df	*P*
Cognitive Development				
Intervention Group[a]	*Pretest-Posttest*	-3.3	-6.3	0.001
Control Group[a]	*Pretest-Posttest*	-3.9	-7.6	0.001
Language Development				
Intervention Group[a]	*Pretest-Posttest*	-7.3	-11.6	0.000
Control Group[a]	*Pretest-Posttest*	-5.7	-7.5	0.000
Motor Development				
Intervention Group[a]	*Pretest-Posttest*	-7.7	-12.1	0.000
Control Group[a]	*Pretest-Posttest*	-4.8	-8.4	0.000

Note: Within-group pre–post differences were analyzed using paired *t*-tests (*a*) for normally distributed variables and the Wilcoxon signed-rank test (*b*) for variables with non-normal distributions. Values are reported as *t* or *z* statistics, as appropriate. Statistical significance was set at $p < 0.05$.

Analysis showed significant pre- to posttest improvements in body weight, height, cognitive, language, and motor development in both intervention and control groups ($p < 0.05$), indicating the intervention effectively enhanced these outcomes in children under five.

Analysis of the Effect of Maranti stimulation on the growth and development of children under five

This section analyzes the effect of Maranti stimulation on growth (weight and height) and cognitive, language, and motor development in children under five.

Table 5. Effect of Maranti Stimulation on Growth (Body Weight and Body Height) and Cognitive, Language and Motor Development of Children under Five

Variable	Maranti Stimulation		*Difference*	CI 95%	*p-value*	*Cohen's d*
	Intervention *Mean* ± SD	Control *Mean* ± SD				
Body Weight	0.3 [0.23]	0.1 [0.29]	0.2	0.04-0.35	0.016	0.724 (medium effect size)
Body Height	1.0 [0.65]	0.4 [0.36]	0.6	0.24-0.85	0.001	1.041 (large effect size)
Cognitive Development	6.3 [9.10]	7.6 [9.69]	-1.3	-6.76–4.17	0.635	-0.141 (no effect size)
Language Development	11.6 [7.59]	7.5 [6.49]	4.1	-0.01-8.17	0.025	0.580 (medium effect size)
Motor Development	12.2 [7.43]	7.6 [7.91]	4.6	0.10-9.04	0.045	0.595 (medium effect size)

Note: Values are presented as mean ± SD. Differences between intervention and control groups were analyzed using independent *t*-tests. Effect sizes were calculated using Cohen's *d* and interpreted as small (0.2), medium (0.5), or large (0.8). Statistical significance was set at $p < 0.05$.

Table 5 shows that Maranti stimulation significantly increased body weight ($p < 0.05$) with a medium effect size (Cohen's $d = 0.724$) and body height ($p < 0.05$) with a large effect size (Cohen's $d = 1.041$) in children under five. While language ($p < 0.05$, $d = 0.580$) and motor development ($p < 0.05$, $d = 0.595$) also improved significantly with moderate effects, Maranti stimulation had no significant impact on cognitive development ($p > 0.05$, $d = -0.141$). Overall, Maranti stimulation positively affects growth and certain developmental domains but not cognitive development.

DISCUSSION

Stunting mainly results from inadequate nutrition during preconception, pregnancy, and the first year of life (11,24). Nutrition-focused interventions and stimulation by health workers, cadres, and parents during the first 1000 days support optimal infant growth and development (25). Touch therapy and massage effectively enhance growth and development (26).

Baseline data showed homogeneity between groups, confirming that changes were due to the intervention. Most children were aged 31–36 months (47.8% and 48.0%), a key stage for rapid cognitive, language, and motor development, ideal for stimulation (27). Gender differences were minor, with similar developmental potential for boys and girls.

Maternal education varied: 39.1% of mothers in the intervention group had college degrees, while 60% in the control group completed senior high school. Higher education likely improves support for child development (28). Employment was evenly split, influencing time for child stimulation (29). According to the papers retrieved, maternal education and economic or family income are factors that contribute to the occurrence of stunting (30).

About 60% of children were born vaginally and at full term (>37 weeks), both linked to better recovery and development (31). Maternal knowledge on stimulation was moderate in the intervention group (65.2%) and good in the control group (60%), reflecting differences in understanding effective techniques (32).

Effect of Maranti Stimulation on Children's Growth

Infant massage promotes relaxation, better sleep, and weight gain by activating the parasympathetic nervous system, positively affecting growth in children under five (20,21).

This study's t-test results confirm that Maranti stimulation significantly increases weight, supporting findings from Sukamti (33) and Haryanti (34) on massage improving infant weight and preventing stunting. Massage therapy constitutes an intervention predicated on tactile stimulation that mechanistically facilitates the growth and development of infants. This therapeutic modality operates by stimulating the vagus nerve, which subsequently enhances parasympathetic activity, thereby expediting intestinal peristalsis, gastric emptying, and appetite, ultimately leading to an increase in caloric intake and nutrient assimilation. Furthermore, massage therapy enhances hemodynamic circulation and tissue oxygenation, thereby fostering musculoskeletal development and motor coordination. From a theoretical standpoint, massage therapy aligns with the paradigms of sensory integration and attachment, which emphasize the importance of human tactile interaction in optimizing neurodevelopmental pathways from infancy. In populations vulnerable to stunting, this intervention effectively addresses proximal determinants, including metabolic inefficiency and elevated cortisol levels associated with stress, which can impede growth. Consequently, the incorporation of massage therapy into antenatal and postnatal care protocols is advocated as an evidence-based preventive approach to bolster the biopsychosocial resilience of infants (35).

Consistent with Rakhmawati et al (35), this study shows infant massage enhances growth (weight, length) and development (motor, language skills) compared to no massage. Other research highlights tactile and oral stimulation combined with massage boosts growth indicators (19). Massage may also stimulate growth hormone secretion, essential for bone lengthening (36). These findings support Maranti stimulation as a practical intervention for growth issues in children at risk of stunting. Successful implementation should consider baseline homogeneity and monitor factors like nutrition and parental involvement. Early infant massage helps prevent stunting by increasing body length, as documented by Sutarmi (19). When combined with nutrition and developmental support, massage is a promising strategy to reduce stunting in under-fives (26).

Previous pediatric massage studies suggest that tactile interventions can modulate autonomic and endocrine stress systems in ways that may support growth and behavioural regulation. Trials in preterm infants have reported that massage increases vagal activity and gastric motility, which in turn has been proposed as one pathway linking massage to greater weight gain (37,38). Umbrella and narrative reviews also indicate that massage therapy in young children may reduce markers of physiological stress and improve sleep and behavioural states, although the strength of the evidence varies across outcomes (38,39). In undernourished infants, baby massage has been associated with increased insulin-like growth factor-1 (IGF-1) levels and decreased cortisol (40). Taken together, these findings provide plausible mechanistic explanations, through enhanced parasympathetic activity, hormonal changes, and improved stress regulation, for the growth and developmental benefits observed in our study. However, because we did not directly measure autonomic or hormonal markers, these mechanisms should be interpreted as theoretical propositions informed by previous research rather than demonstrated outcomes of the present trial.

The Effect of Maranti Stimulation on Development

Maranti massage targets the head and face to enhance cerebral blood flow, stimulate cranial nerves, boost sensory awareness, and strengthen oral muscles. This study found that Maranti had no significant effect on cognitive development, but it had positive impact on language and motor development in children under five, confirming massage as a useful neuromotor stimulus. Variations in sample age, massage frequency, techniques, and environmental factors such as home stimulation, nutrition, and genetics likely limit massage's effectiveness as a sole intervention for cognitive gains. Nonetheless, massage offers other benefits, including improved weight, length, and infant relaxation, supporting its role in a holistic approach to child growth, though further controlled research is needed on its cognitive effects.

This study aligns with a meta-analysis of nine studies reported by Chen *et* al., showing infant massage did not significantly improve psychomotor development despite a slight positive trend (39). Some researchers can report from a theoretical standpoint, this outcome was understandable by the critical period sensitivity framework, which holds that interventions in the toddler phase may miss the peak period of synaptogenesis in the prefrontal cortex that supports executive function and memory because the optimal window of neuroplasticity for tactile stimulation of cognitive domains tends to be earlier (around 0–12 months) (41). Additionally, dose-response models in developmental neuroscience suggest that suboptimal stimulation intensity, characterized by treatment sessions that do not impact epigenetic modifications to the expression of the brain-derived neurotrophic factor (BDNF) gene, may limit adaptive responses (39).

This study consistent with Pastari dan Syokumawena (42), who reported significant language improvements in autistic children receiving oro-motor massage combined with speech therapy. Similarly, Siregar et al (43) and Budiarti et al (44) found oro-motor massage enhances speech and oral muscle function in young children, supporting its role in language development. Thus, Maranti massage, particularly its oro-motor component, can effectively promote language skills and could be integrated with other therapies for better outcomes.

Meta-analytic evidence indicates that early stunting is linked to persistent cognitive deficits into later childhood and adolescence (45). Trials from Jamaica further show that meaningful cognitive catch-up in stunted children typically requires high-intensity psychosocial stimulation delivered weekly over two years (46,47). In contrast, our Maranti protocol consisted of once-weekly sessions over six weeks and focused primarily on tactile input rather than structured play or language-rich activities. Systematic reviews of early childhood development and parenting interventions also highlight that longer duration, greater intensity, and comprehensive packages that target both caregivers and the home environment produce larger cognitive gains (48). Moreover, observational studies underscore the role of psychosocial stimulation and home learning environments as key moderators of cognitive outcomes, beyond nutrition alone (49,50). Together, these findings help explain why our relatively brief massage-based intervention improved growth and some developmental domains but did not yield measurable effects on cognitive scores.

Further research is needed to identify infants most responsive to massage and to clarify the physiological mechanisms behind its effects on motor development. Previous studies support massage's positive impact on fine and gross motor skills, sucking reflex, and overall development (19,51). In conclusion, Maranti massage positively affects motor development but its impact on psychomotor function requires more investigation. The benefits of infant massage extend beyond physical growth to emotional and sensory support, promoting holistic child development. More detailed studies are essential to optimize infant massage as part of comprehensive child development programs.

CONCLUSION

The Maranti stimulation intervention effectively improves growth and development in stunted children under five. It significantly increased body weight (moderate effect size, Cohen's d = 0.58) and height (large effect size, Cohen's d = 1.04) compared to the control group, showing a strong impact on physical growth.

In terms of development, Maranti stimulation had a moderate positive effect on language (Cohen's d = 0.58) and motor skills (Cohen's d = 0.60). However, it showed no significant effect on cognitive development (very small effect size, Cohen's d = -0.14), indicating its benefits are mainly physical and motor related.

Overall, the study confirms that Maranti stimulation supports improvements in weight, height, language, and motor development in stunted children. It can be used as a complementary approach in stunting management

programs to boost physical growth and motor skills. Further research is needed to explore its impact on cognitive development and related factors.

AUTHOR'S CONTRIBUTION STATEMENT

Dewi Rokhanawati contributed to the study's conception and design, data acquisition, and data analysis, wrote the first draft of the manuscript, revised the final draft, and gave final approval of the version to be published.

Nidatul Khofiyah contributed to the study's conception and design, data acquisition, and data analysis, wrote the first draft of the manuscript, revised the final draft, and gave final approval of the version to be published.

Elika Puspitasari contributed to the data acquisition, data analysis and wrote the first draft of the manuscript.

CONFLICTS OF INTEREST

There were no financial or commercial conflicts of interest throughout this study and state that they have no competing interests with the funders.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors declare that AI-assisted technologies were used to support the writing process of this manuscript. Specifically, Grammarly was utilized to assist with grammar correction, spelling, and clarity improvement, particularly due to the authors not being native English speakers. No content was generated by generative AI models such as ChatGPT or other large language models. The use of Grammarly did not influence the scientific content, interpretation of data, or conclusions presented in this manuscript.

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