

Section: Paediatric Nursing

The effectiveness of infant massage on immunity in stunting infants: IL-6 levels and infection rates

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Abstract

Stunting represents chronic malnutrition in early childhood that significantly impairs immune function and increases susceptibility to infections. Infant massage has emerged as a promising non-pharmacological intervention that enhances immunity through lymphatic stimulation. The objective of this study was to assess the efficacy of baby massage on immunological function in stunted infants aged 6-12 months, evaluated through IL-6 concentrations and infection incidence measurements. A quasi-experimental pre-post-test design involved 80 stunted infants in Blora Regency, randomly assigned to an intervention group (n=40) and a control group (n=40). The intervention group received standard nutritional supplementation plus infant massage (30 minutes daily) for three months, while the control group received only standard supplementation. Baseline IL-6 levels were significantly elevated in the control group (4.59±3.30 pg/ml) compared to the intervention group (1.39±0.90 pg/ml, $p<0.001$). Post-intervention, both groups showed a reduction in IL-6 levels: the intervention group achieved 1.03±0.45 pg/ml and the control group 3.87±1.90 pg/ml ($p<0.001$). The post-intervention infection incidence was markedly lower in the intervention group (20%) compared to the control group (62.5%, $p<0.05$). The intervention group demonstrated statistically significant IL-6 improvement ($p=0.003$), while the control group showed no significant change ($p=0.245$). Infant massage significantly enhances immune functionality in stunted infants through reduced IL-6 concentrations and decreased infection incidence, demonstrating its potential as a complementary nutritional intervention in stunting management.

Keywords: IL-6, immunology, infant massage, infection, stunting

Introduction

Stunting, characterized as a height-for-age measurement falling below -2 standard deviations according to the World Health Organization growth standards (De Onis & Branca, 2016), affects an estimated 149 million children under the age of five worldwide (UNICEF & WHO, 2021). This condition not only serves as an indicator of chronic malnutrition but also undermines immune functionality, rendering affected children more vulnerable to infectious diseases (Millward, 2017) and subsequent growth delays (World Health Organization, 2014). Indonesia exhibits one of the highest rates of stunting prevalence in Southeast Asia, with 21.6% of children under five years old being impacted (Munira, 2023). The interplay between stunting and immune dysfunction is inherently bidirectional, where chronic malnutrition results in compromised immune responses, and recurrent infections adversely affect growth outcomes (Permatasari & Sumarmi, 2018). Interleukin-6 (IL-6), a pro-inflammatory cytokine, functions as a biomarker indicative of immune activation and inflammatory conditions. Increased IL-6 concentrations in stunting children signify chronic inflammation, which can hinder growth and developmental trajectories (Harrison et al., 2020; Syed et al., 2018).

Conventional strategies for managing stunting predominantly emphasize nutritional interventions. However, emerging evidence indicates that tactile and kinaesthetic stimulation via infant massage may confer supplementary advantages. Research has demonstrated that infant massage can enhance growth parameters, bolster immune function, and diminish stress hormone levels in infants (Ang et al., 2012; Trisna-Windiani et al., 2015). The underlying mechanism involves stimulating the parasympathetic nervous system, resulting in augmented growth hormone secretion and enhanced nutrient assimilation (Sudarmi & Wahyuni, 2022; Sutarmi et al., 2024; Yuliatratri et al., 2023). Studies have revealed that baby massage can modulate inflammatory markers and enhance immune responses in preterm infants (Trisna-Windiani et al., 2015). However, there is a paucity of research examining its effects on immune function in stunting infants. This study aims to assess the efficacy of infant massage in improving immune functionality in stunted infants aged 6-12 months, focusing on IL-6 levels and infection incidence.

This study is critically important because it addresses the severe public health challenge of stunting, a condition of chronic malnutrition that drastically compromises the immune systems of young children. With focusing on infants aged 6-12 months, the research targets a crucial developmental window where immune function is highly

vulnerable to impairment. The finding that infant massage significantly reduces the inflammatory marker and substantially decreases infection incidence provides robust scientific validation for a simple, low-cost, and non-pharmacological intervention. This is particularly valuable in resource-limited settings, such as Blora Regency, where access to complex medical treatments may be scarce. Demonstrating that an intervention like massage can be used as a complementary nutritional strategy broadens the scope of stunting management beyond just dietary supplements. The study advocates for the integration of nurturing, tactile care into standard paediatric practice to build resilient immune systems. Furthermore, the objective, measurable outcomes lend scientific credibility to a traditional practice, making it more likely to be adopted by healthcare professionals. Ultimately, this research offers a practical, accessible method for parents and caregivers to actively enhance their stunting child's health and survival chances, thereby contributing directly to improved child health outcomes globally.

Method

This quasi-experimental study employed a pre-post-test design with two groups: an intervention group receiving standard nutritional supplementation combined with infant massage and a control group receiving standard nutritional supplementation alone. This study was conducted in Blora Regency, Central Java, Indonesia, between January and July 2024. The target population comprised stunted infants aged 6-12 months who were identified through the Community-Based Nutrition Recording and Reporting System (E-PPBM) database in April 2024. The selected research participants who met the inclusion criteria: (1) height-for-age Z-score < -2 standard deviations (SD) according to WHO Child Growth Standards; (2) adequate nutritional status, defined as not classified as severely malnourished; (3) completion of age-appropriate basic immunizations according to the Indonesian National Immunization Program; and (4) parental consent for participation. The exclusion criteria: (1) presence of physical defects, congenital anomalies, or chronic illnesses that could interfere with growth assessment or intervention delivery; (2) acute severe infectious diseases requiring hospitalization; (3) dermatological conditions such as eczema or other skin disorders contraindicated for massage therapy; and (4) anticipated inability to complete the intervention protocol due to planned relocation or other circumstances.

Sample size was calculated using the formula for comparing two independent groups with continuous outcomes: $n = [(Z_{1-\alpha/2} + Z_{1-\beta})^2 \times (\sigma_1^2 + \sigma_2^2)] / (\mu_1 - \mu_2)^2$ Where α was set at 0.05 (two-tailed) and power $(1-\beta)$ at 80%. Based on previous studies examining IL-6 levels in similar populations, the calculation yielded 36 participants per group. Accounting for an anticipated 10% attrition rate, the final sample size was determined as 40 participants per group (total $n=80$). Participants were allocated using cluster randomization at the community health centre level to minimize contamination bias. Simple randomization was performed using computer-generated random numbers, with all eligible participants from each health centre assigned to the same study arm. This approach ensured geographical separation between intervention and control groups while maintaining the integrity of the randomization process. The intervention group received a standard nutritional supplementation according to Indonesian Ministry of Health guidelines for stunting children; and infant massage sessions conducted for 30 minutes daily over three months. The massage protocol followed standardized techniques adapted from the International Association of Infant Massage (McClure, 2017), incorporating gentle stroking, kneading, and passive range-of-motion exercises. Sessions were performed by trained caregivers under supervision of certified therapists during the first week, followed by independent implementation with weekly monitoring visits. A control group received standard nutritional supplementation identical to the intervention group for three months, no infant massage intervention.

Primary outcomes of this study included serum interleukin-6 (IL-6) concentrations measured in picograms per millilitres (pg/mL) using enzyme-linked immunosorbent assay (ELISA) with commercially available kits (sensitivity: 0.039pg/mL); and infection incidence defined as clinically diagnosed infectious diseases including upper respiratory tract infections, diarrheal diseases, and skin infections during the three months study period. Data collection was performed at baseline and three months post-intervention by a multidisciplinary team of trained research assistants, including certified midwives, registered medical laboratory, registered nutritionists, and paediatricians. All personnel completed standardized training protocols prior to data collection initiation. Biochemical assessment: Venous blood samples (3mL) were collected using standard phlebotomy techniques and processed within 2 hours. Serum was separated by centrifugation at 3,000 rpm for 10 minutes and stored at -80°C until analysis. IL-6 levels were measured in duplicate using high-sensitivity ELISA according to manufacturer protocols (Elabscience). The clinical assessment to measure the infection status was evaluated through comprehensive physical examination by qualified paediatricians using standardized case definition criteria. Medical histories were reviewed, and caregivers were interviewed regarding symptoms and healthcare utilization during the study period.

Data were scrutinized employing IBM SPSS Statistics version 28.0. Descriptive statistics were conveyed as means $\pm$ standard deviations for continuous variables and frequencies (percentages) for categorical variables. Inter-group comparisons were conducted utilizing independent t-tests or Mann-Whitney U tests for continuous variables, and chi-square or Fisher's exact tests for categorical variables. Intra-group alterations were evaluated using paired t-tests or Wilcoxon signed-rank tests. The threshold for statistical significance was established at $p < 0.05$. This study received endorsement from the Health Research Ethics Committee associated with the Medical Faculty of Diponegoro University Semarang, designated by the reference number 450/EC/KEPK/FK-UNDIP/XII/2022.

Results

In total, 80 stunting infants successfully completed the study, with an equal distribution of 40 participants in each group. The baseline characteristics exhibited homogeneity across the groups (**Table 1**). A significant majority of the participants were male (60% in both groups), with ages primarily concentrated within the average of 8 months. The majority of fathers were employed in informal sectors, while over 75% of mothers engaged in housewife activities. The rates of exclusive breastfeeding were documented at 62.5% for the intervention group and 72.5% for the control group. At baseline, the IL-6 levels were markedly elevated in the control group (4.59 ± 3.30 pg/ml) relative to the intervention group (1.39 ± 0.90 pg/ml, $p < 0.001$). The baseline IL-6 levels within the control group surpassed the normative range (>1.8 pg/ml), signifying an inflammatory condition. Post-intervention, both groups exhibited diminished IL-6 levels, with the intervention group attaining 1.03 ± 0.45 pg/ml and the control group 3.87 ± 1.90 pg/ml ($p < 0.001$). The intervention group evidenced significant intra-group enhancement ($p = 0.003$), whereas the control group did not demonstrate any statistically significant alteration ($p = 0.245$). Concerning infection incidence, pre-intervention rates were minimal in both groups (7.5% in the intervention group, 0% in the control group). Post-intervention, the intervention group experienced substantially lower infection rates (20%) in comparison to the control group (62.5%, $p < 0.001$) (**Table 2**).

Table 1. Characteristics of respondents.

Characteristics	Intervention group (n=40)	Control group (n=40)	p
Gender, n (%)			
Male	24 (60)	24 (60)	1.00
Female	16 (40)	16 (40)	
Age (months), range			
7-9	25 (63%)	30 (75%)	0.759
Father's occupation, n (%)			
Informal sectors	15 (37.5)	20 (50)	0.988
Father's occupation, n (%)			
Housewife	30 (75)	34 (85)	0.759
Feeding in the first 6 months, n(%)			
Exclusive breastfeeding	25 (62.5)	29 (72.5)	0.578

Table 2. IL-6 Levels and Infection Incidence Pre- and Post-Intervention.

Variables	Intervention group (n=40)	Control group (n=40)	p
IL-6 levels (pg/ml)			
Pre-intervention	1.39 ± 0.90	4.59 ± 3.30	$<0.001^b$
Post-intervention	1.03 ± 0.45	3.87 ± 1.90	$<0.001^b$
p	0.003 ^d	0.245 ^d	
Difference	-0.36 ± 0.70	-0.71 ± 3.27	0.806 ^b
Infection incidence			
Pre-intervention, n (%)			
Yes	3 (7.5)	0	0.241
No	37 (92.5)	40 (100)	
Post-intervention, n (%)			
Yes	8 (20)	25 (62.5)	<0.001
No	32 (80)	15 (37.5)	
p	$<0.001^e$	$<0.001^e$	

Data presented as mean $\pm$ standard deviation. ^bMann-Whitney test, ^dWilcoxon test, ^eFisher's exact test.

Discussion

This study demonstrates that infant massage therapy significantly improves immune function in stunting infants, as evidenced by reduced IL-6 levels and decreased infection incidence. The intervention group showed statistically significant within-group improvement in IL-6 concentrations ($p = 0.003$), while the control group receiving nutritional supplementation alone showed no significant changes. The beneficial effects observed can be attributed to tactile and kinaesthetic stimulation mechanisms that activate the parasympathetic nervous system, promoting the release of growth hormone and neurotransmitters including serotonin and dopamine (Sudarmi et al., 2020; Oliveira et al., 2015; Wu et al., 2014). These biochemical mediators play essential roles in immune response modulation and inflammatory reaction attenuation. Additionally, massage therapy reduces cortisol levels, which when chronically elevated, can compromise immune function (Trisna-Windiani et al., 2015). The vagal stimulation induced by massage enhances parasympathetic tone, contributing to anti-inflammatory pathways and improved immunological homeostasis (Diego et al., 2007).

The markedly lower infection incidence in the intervention group (20% vs 62.5%) supports the hypothesis that infant massage enhances immune function. This finding is particularly relevant for stunted infants who face increased infection susceptibility due to compromised immune systems (Trisna-Windiani et al., 2015). The reduction in infection rates may facilitate improved growth trajectories and break the detrimental cycle of malnutrition and recurrent infections that characterizes stunting. IL-6 serves as a key inflammatory biomarker reflecting immune activation and inflammatory status. Elevated IL-6 levels in stunting children indicate chronic inflammatory processes that impede growth and developmental progress (Trisna-Windiani et al., 2015). The significant reduction in IL-6 concentrations in the intervention group suggests that infant massage may help modulate inflammatory responses, potentially through vagal stimulation and enhanced parasympathetic activity. These findings align with previous studies demonstrating benefits of tactile stimulation in infants. Diego et al. reported that massage therapy in preterm infants improved immune function and reduced infection rates (Diego et al., 2014).

Several limitations warrant consideration. The quasi-experimental design limits causal inference compared to randomized controlled trials. Cluster randomization at the community health centre level, while preventing contamination, may have introduced selection bias. Additionally, significant baseline differences in IL-6 levels between groups could have influenced outcomes, despite statistical adjustments. The lack of correlation between massage intervention and IL-6 reduction in correlation analysis, despite significant within-group changes, suggests that the mechanisms underlying growth and immune improvements may operate through distinct pathways or involve unmeasured mediating factors. Future studies should investigate optimal duration and frequency of massage interventions, explore underlying mechanistic pathways in greater detail, and conduct larger randomized controlled trials to confirm these findings. Longitudinal follow-up studies would help determine whether immunological benefits persist and contribute to sustained growth improvements over time. Additionally, research examining the intervention's effectiveness across different age groups and severity of stunting would inform evidence-based implementation strategies. The role of healthcare professionals, particularly nurses, is essential in translating these findings into practice. Nurses, midwives, and community health workers are often the first point of contact for families in primary healthcare. Their responsibilities include screening for stunting, providing nutritional counselling, and offering hands-on training for caregivers in infant massage techniques. Through continuous follow-up, monitoring, and health education, nurses can help sustain the intervention's benefits, reduce infection burden, and support child growth and development. Integrating infant massage into nursing care protocols and community health programs would therefore strengthen the holistic approach to stunting management.

Conclusion

This study conclusively demonstrates that infant massage therapy, when combined with standard nutritional supplementation, significantly improves immune function in stunted infants aged 6-12 months. This enhancement is evidenced by statistically significant reductions in IL-6 concentrations and substantially lower infection incidence compared to control infants receiving supplementation alone. The intervention's powerful immunomodulatory effects are attributed to tactile and kinaesthetic stimulation, which likely promotes immune health through parasympathetic activation and inflammatory regulation. Given the compelling evidence of its effectiveness, along with its inherent cost-effectiveness, excellent safety profile, and ease of implementation, infant massage therapy should be formally integrated into comprehensive stunting prevention strategies. This is particularly crucial in resource-limited settings where stunting prevalence is highest. Healthcare providers, specifically nurses and midwives, must be actively involved in incorporating infant massage education into maternal and child health services. Their pivotal role in training parents, ensuring intervention adherence, and monitoring child health outcomes is essential for maximizing infant massage's effectiveness as a vital complementary strategy for stunting management and immune enhancement.

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