



Original Article

Effect of *Moringa oleifera* leaf powder supplementation on acute respiratory infection in children aged 36–59 months: a quasi-experimental study

Nurhi Kefi Nomenci Babu ¹, Fitriyono Ayustaningwarno ^{2✉}, Nuryanto ², Diana Nur Afifah ²

¹ Master of Nutrition Science, Faculty of Medicine, Universitas Diponegoro, Semarang, Central Java, Indonesia

² Department of Nutrition, Faculty of Medicine, Universitas Diponegoro, Semarang, Central Java, Indonesia

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CORRESPONDENCE

Phone: +6281287664576

E-mail: ayustaningwarno@live.undip.ac.id

A B S T R A C T

Background: Acute Respiratory Infection (ARI) remains a leading cause of morbidity and mortality among children under five, particularly in settings with poor nutritional status and sanitation. *Moringa oleifera* has been recognized for its nutritional and immunomodulatory properties; however, evidence regarding its effect on ARI incidence in undernourished children is still limited.

Objective: This study aimed to examine the effect of *Moringa oleifera* leaf powder supplementation on the incidence of ARI among children aged 36–59 months.

Methods: A quasi-experimental study with a pretest–posttest control group design was conducted from May to July 2025 at Batuputih Public Health Center, South Central Timor District, Indonesia. A total of 40 children were equally allocated into intervention and control groups. The intervention group received 15 g/day of moringa leaf powder combined with eggs, vitamin C, and B complex for 60 days, while the control group received the same supplementation without moringa. ARI incidence was assessed based on clinical diagnosis and hematological parameters, including leukocyte, lymphocyte, and monocyte counts. Data were analyzed using appropriate non-parametric and parametric tests, with statistical significance set at $p < 0.05$.

Results: The intervention group showed a greater reduction in ARI incidence compared with the control group (from 20 to 3 children vs. 20 to 9 children; $p = 0.038$). Significant changes were also observed in leukocyte levels following supplementation ($p = 0.007$).

Conclusion: *Moringa oleifera* leaf powder supplementation was associated with a reduction in ARI incidence among children aged 36–59 months and may serve as a potential supportive nutritional intervention in high-risk populations.

INTRODUCTION

Acute Respiratory Infection (ARI) remains one of the leading causes of morbidity and mortality among children under five, accounting for approximately 15% of global childhood deaths, most commonly due to pneumonia. In Indonesia, ARI continues to be a major public health concern, with a reported prevalence of approximately 12.8% among children under five and considerable regional variation. The burden is particularly high in vulnerable provinces such as East Nusa Tenggara, where adverse social determinants, including inadequate nutritional intake and poor sanitation, contribute to compromised child health outcomes.

At the local level, respiratory infection cases in Timor Tengah Selatan Regency account for more than 20% of annual clinical visits among children at primary healthcare facilities, including Batuputih Public Health Center.^{1,2} This substantial burden is further exacerbated by widespread undernutrition, exposure to indoor air pollution, substandard housing conditions, and limited access to clean water, all of which impair immune function and increase susceptibility to infection.^{2,3}

Moringa oleifera leaves are recognized as a nutrient-dense local food source, rich in protein, vitamins, essential minerals, and bioactive compounds with antioxidant and immunomodulatory properties.⁴⁻⁷ Previous studies have demonstrated that moringa supplementation improves nutritional status and hemoglobin levels in children,

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highlighting its potential as a community-based dietary intervention. However, most existing studies have focused on single outcomes, particularly nutritional status or anemia, without simultaneously evaluating infection incidence and immune-related hematological parameters.^{8,9}

To date, no study has concurrently examined the effect of moringa leaf powder supplementation on ARI incidence alongside immune-related hematological parameters, including leukocyte, lymphocyte, and monocyte levels, in ARI-endemic settings such as Timor Tengah Selatan Regency. This integrated assessment of clinical and immunological outcomes represents the primary novelty of the present study. Therefore, this study aimed to examine the effect of *Moringa oleifera* leaf powder supplementation on the incidence of ARI among children aged 36–59 months in the working area of Batuputih Public Health Center.

METHOD

Study Design

This study employed a quasi-experimental design with a pretest–posttest control group approach.¹⁰

Setting and Participants

The study was conducted from May to July 2025 at Batuputih Public Health Center, South Central Timor District, Indonesia. A total of 40 children aged 36–59 months diagnosed with mild ARI were included. Inclusion criteria were children aged 36–59 months with mild ARI, without chronic diseases, and whose parents provided written informed consent. Exclusion criteria included children with chronic diseases, severe ARI, allergies to moringa or eggs, incomplete participation during the 60-day intervention, or lack of parental consent. Participants were selected using purposive sampling.

The Variable, Instrument, and Measurement

The primary outcome of this study was ARI incidence, while secondary outcomes included hematological parameters (leukocyte, lymphocyte, and monocyte levels). ARI incidence was determined by healthcare professionals based on clinical diagnosis, defined as the presence of at least 2 symptoms (cough, cold, and fever $\geq 38^{\circ}\text{C}$), and verified using medical records from the community health center.

Laboratory examinations were conducted at Mamami Hospital, Kupang, using a calibrated Swelab Alfa hematology analyzer. Anthropometric measurements (body weight and height) were performed biweekly using calibrated digital scales and a stadiometer to assess nutritional status. Data were collected before and after the intervention using standardized case report forms and laboratory records.

Intervention Procedure

Participants were allocated into intervention and control groups. The intervention group received 15 g/day of

Moringa oleifera leaf powder for 60 days, administered as part of daily meals. In addition, both groups received eggs, vitamin C, B complex supplementation, and maternal health education. The control group received the same intervention without moringa supplementation. Baseline data, including ARI incidence, hematological parameters, and anthropometric measurements, were collected prior to the intervention. Follow-up assessments were conducted after 60 days using the same procedures.

Data Analysis

Data were analyzed using chi-square and Mann–Whitney tests according to data distribution. Statistical significance was set at $p < 0.05$.

Ethical Consideration

This study received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Diponegoro University, Semarang (No. 084/EC/KEPK/FK UNDIP/IV/2025).

RESULTS

Participant Characteristics

Table 1 presents the baseline characteristics of the study participants. The mean age of children was comparable between groups. The majority of children in both groups were underweight and stunted, although most had normal weight-for-height status.

Table 1. Baseline Characteristics of Study Participants (n = 40)

Characteristics	Control Group (n=20)	Intervention Group (n=20)
Age (month)	45.15 ± 5.84	46.90 ± 5.90
Sex		
Male	8 (40%)	11 (55%)
Female	12 (60%)	9 (45%)
Weight-for-age		
Normal Weight	1 (5%)	2 (10%)
Underweight	18 (90%)	17 (85%)
Severely underweight	1 (5%)	1 (5%)
Height-for-age		
Normal	0 (0%)	11 (55%)
Stunted	11 (55%)	9 (45%)
Severely Stunted	9 (45%)	0 (0%)
Tall	0 (0%)	0 (0%)
Weight-for-height		
Good Nutrition	10 (50%)	11 (55%)
Mild Malnutrition	10 (50%)	6 (30%)
Severe Malnutrition	0 (0%)	3 (15%)
At Risk of Overweight	0 (0%)	0 (0%)
Overweight	0 (0%)	0 (0%)
Obesity	0 (0%)	0 (0%)

Table 2. Effect of *Moringa oleifera* Supplementation on ARI Incidence and Laboratory Parameters

Variable	Group	Pretest	Posttest	p-value Within Group	p-value Between Groups
ARI incidence, n (%)	Intervention	20 (100%)	3 (15%)	< 0.001	0.038
	Control	20 (100%)	9 (55%)	< 0.001	
Leukocyte ($\times 10^3/\mu\text{L}$)	Intervention	12.30 (12.1 – 12.6)	11.95 (11.1 – 13.6)	0.025	0.007
	Control	12.25 (12.1 – 12.5)	12.00 (11.9 – 12.6)	0.123	
Lymphocyte ($\times 10^3/\mu\text{L}$)	Intervention	5.20 (5.0–5.8)	5.00 (4.8 – 5.9)	0.033	0.389
	Control	5.30 (5.1 – 5.9)	5.00 (4.7 – 5.8)	0.153	
Monocyte ($\times 10^3/\mu\text{L}$)	Intervention	0.90 (0.7 – 1.1)	0.95 (0.7 – 1.2)	0.025	0.500
	Control	0.95 (0.7 – 1.2)	1.00 (0.5 – 1.3)	0.263	

Note: Data are presented as n (%) for ARI incidence and median (min–max) for laboratory parameters. Within-group comparisons were analyzed using McNemar or Wilcoxon tests, and between-group comparisons using chi-square or Mann–Whitney tests.

Effect of *Moringa* Supplementation on ARI and Laboratory Parameters

Table 2 shows the changes in ARI incidence and laboratory parameters before and after the intervention. The intervention group demonstrated a significant reduction in ARI incidence from 100% (n = 20) to 15% (n = 3), compared with a reduction from 100% to 55% (n = 9) in the control group (between-group p = 0.038). Leukocyte levels decreased significantly in the intervention group compared with the control group (p = 0.007). However, no significant differences were observed between groups in lymphocyte and monocyte levels (p > 0.05).

DISCUSSION

This study found that baseline child characteristics, particularly nutritional status, were strongly associated with the risk of acute respiratory infection (ARI). Most participants were aged 36–47 months and presented with underweight and stunting, conditions known to impair mucosal protection, antibody synthesis, and overall host defense, thereby increasing susceptibility to respiratory pathogens.^{11–13} Immune vulnerability at this age is further influenced by ongoing immune system maturation and early exposure to environmental pathogens.^{14,15}

Moringa supplementation in the intervention group was associated with a significant reduction in ARI incidence compared with controls, accompanied by a meaningful decrease in leukocyte levels, indicating reduced systemic inflammatory activity.^{16,17} The direction of this effect is consistent with previous evidence showing that moringa-based supplementation improves nutritional status and immune competence, although most prior studies focused on single outcomes such as growth or hemoglobin rather than infection incidence combined with immune markers.^{18,19}

The beneficial effects of *Moringa oleifera* may be explained by its rich nutritional and bioactive composition, including proteins, vitamins, and antioxidant polyphenols, which play important roles in modulating immune responses and reducing inflammation.²⁰ Its polyphenols and flavonoids act as strong antioxidants that protect the respiratory mucosa

from oxidative stress, thereby reducing pathogen entry.^{21,22} *Moringa*'s bioactive compounds may also modulate immune responses by inhibiting NF- κ B-mediated inflammation, reducing pro-inflammatory cytokines, and enhancing T- and B-cell activity, including IgA production for mucosal defense.²³ These combined antioxidant, anti-inflammatory, and immunomodulatory effects provide a plausible biological explanation for the observed reduction in ARI incidence and leukocyte levels

Importantly, the absence of significant associations in multivariate models should be interpreted with caution. The observed odds ratios (0.000–0.000) are not epidemiologically plausible and likely reflect limited variability in baseline characteristics, particularly the high prevalence of malnutrition among participants. This lack of variability restricts model stability and should be considered a methodological limitation rather than a true absence of association.²⁴

Several limitations should be acknowledged. The sample size was relatively small, the intervention duration was limited to 60 days, and dietary intake was not monitored. In addition, immune assessment relied only on basic hematological parameters, which may not fully capture underlying immunological mechanisms such as cytokine responses or antibody production. Environmental factors such as indoor air pollution, housing conditions, and water access were also not fully controlled and may have influenced ARI outcomes.

Despite these limitations, this study provides important preliminary evidence that moringa supplementation, as a locally available nutritional resource, may reduce ARI incidence and inflammatory burden among nutritionally vulnerable children. The consistent improvement in clinical outcomes and leukocyte profiles supports its potential as a low-cost, community-based nutritional intervention in high-risk settings.

CONCLUSIONS AND RECOMMENDATION

Moringa oleifera leaf powder supplementation for 60 days was associated with a reduction in ARI incidence and leukocyte levels among children aged 36–59 months,

indicating a potential role in modulating inflammatory responses. These findings support the use of moringa as an affordable nutritional intervention in high-risk settings. Further studies with larger sample sizes, longer follow-up periods, and more comprehensive immunological markers are needed to confirm its mechanisms and long-term effects.

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