World Nutrition, June 2026;17(2): 94-101
DOI: https://doi.org/10.26596/wn.202617294-101

WORLD NUTRITION
The Official Journal of the World Public Health Nutrition Association
Journal homepage: https://www.worldnutritionjournal.org
ISSN: 2041-9775

Research Article

Nutrition education alone is insufficient to achieve clinically meaningful recovery from moderate acute malnutrition in under-five children: A randomised four-arm community trial in Nigeria

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Article History
Received: April 04, 2026
Reviewed: April 09, 2026
Revised: June 01, 2026
Accepted: June 06, 2026
Published: June 30, 2026

Citation
Adesanmi R.A., Nwamarah J.U., Malomo S.A., & Okorie I. (2026). Nutrition education alone is insufficient to achieve clinically meaningful recovery from moderate acute malnutrition in under-five children: A randomised four-arm community trial in Nigeria. *World Nutrition*, 17(2), June, 94–101. https://doi.org/10.26596/wn.202617294-101

Academic Editor
Ted Greiner, PhD

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Highlights/Key Messages

- Zero children receiving nutrition education alone recovered from MAM at any of six visits over 90 days.
- All food-supplemented completers (38/38; 100%) achieved recovery, versus 0% in the counselling-only group ($p < 0.001$).
- The WHZ divergence between groups widened at every fortnightly visit, reaching an effect size of Cohen's d = 4.31 at Week 12.

Background
Nutrition education and dietary counselling are the de facto responses to Moderate Acute Malnutrition (MAM) at Nigerian primary health care (PHC) facilities where supplementary food is unavailable. Its efficacy as a standalone MAM intervention has not been examined in a West African randomised trial.

Objective
To document the 90-day anthropometric response of MAM-diagnosed children managed with nutrition education alone versus three food-supplemented groups across six fortnightly assessments.

Methods
Seventy-two children aged 6–59 months with confirmed MAM (WHZ −3 to −2; MUAC 11.5–12.5 cm) were randomised to four arms in Ekiti State, Nigeria: Plumpy Sup RUSF (PST; n=18), maize-soybean (MSB; n=19), maize-peanut (MPN; n=18), and nutrition education only (NE; n=18). Anthropometric outcomes were measured at enrolment and six semi-monthly visits over 90 days. Recovery was defined as WHZ > −2 and MUAC > 12.5 cm.

Results
No child in the NE group achieved MAM recovery at any assessment point (0/7 completers at Week 12; 0%; 95% CI: 0–41%), versus 100% recovery among all food-supplemented completers (38/38; $p < 0.001$). Mean WHZ improved by only +0.19 z-score units in the NE group over 90 days, compared with +1.79 to +2.46 units in food-supplemented groups ($p < 0.001$; Cohen's d = 4.31). Weight gain velocity was 0.20 g/kg/day in the NE group — 8.7% of the Plumpy Sup rate and one-fifth of the 1.0 g/kg/day minimum threshold. The WHZ gap widened monotonically at every visit, from 0.15 z-score units at Week 2 to 1.88 units at Week 12.

Conclusion
Structured nutrition education as the sole MAM intervention produced no clinically meaningful recovery over 90 days. The effect is categorical, consistent from Week 2, and powered at >95% for the binary recovery outcome. Direct food supplementation is indispensable for MAM recovery and must be the minimum standard of care in Nigeria's PHC system.

Keywords: nutrition education; moderate acute malnutrition; supplementary feeding; Nigeria; randomised trial; recovery rate

Introduction

Moderate Acute Malnutrition (MAM), defined as WHZ between −3 and −2 standard deviations of the WHO Child Growth Standards or MUAC of 11.5–12.5 cm without oedema, affects approximately 34 million children under five years globally at any given time (World Health Organization, UNICEF, & World Bank, 2018). Nigeria bears one of the highest national burdens: the 2018 National Nutrition and Health Survey documented a prevalence of 5.5%, equivalent to approximately 3 million affected children (National Nutrition and Health Survey, 2018). Untreated MAM doubles to triples infection-related mortality (Black et al., 2008, 2013; Olofin et al., 2013), impairs cellular and humoral immune function (Rytter et al., 2014; Bourke et al., 2016), and carries a 10–20% risk of progressing to Severe Acute Malnutrition (SAM) within three to six months, at a fourfold higher treatment cost (Briend et al., 2015), with lasting consequences for adult health and human capital (Victora et al., 2008).

Community-based MAM management employs two broad approaches: direct dietary supplementation with ready-to-use supplementary food (RUSF) or fortified blended foods, and behaviour change communication through caregiver nutrition education and dietary counselling (WHO, 2012; Annan et al., 2014). The evidence base for food supplementation is extensive and consistent. Cochrane review evidence (Lazzerini et al., 2013) and randomised trials across sub-Saharan Africa (Matilsky et al., 2009; Nikièma et al., 2014; Prudhon et al., 2017) establish MAM recovery rates of 60–100% over 12–16 weeks. Nutrition education can improve caregiver knowledge and feeding practices, but evidence indicates it cannot reliably alter nutritional status when food insecurity is the binding constraint (Ashworth & Ferguson, 2009; Imdad et al., 2011). Bhutta et al. (2008), synthesising evidence from 35 systematic reviews, found that counselling-only approaches in food-insecure settings produced mean weight-for-age z-score (WAZ) gains of approximately +0.19 WHZ, clinically negligible for a child needing +0.5 to +2.5 WHZ improvement to exit MAM.

Despite this evidence, nutrition education remains the primary response to MAM at most Nigerian PHC facilities, where supplementary foods are unavailable, which, in Ekiti State and most other states, is most of the time (Ekiti State Primary Health Care Development Agency, 2017). This practice persists primarily because of chronic resource constraints and systemic underinvestment in MAM treatment. Donor-supplied RUSF has become increasingly scarce as development partners refocus priorities toward severe acute malnutrition, while government health budgets have not filled the resulting gap, leaving dietary counselling as the de facto response for children who do not meet SAM criteria (Ekiti State Primary Health Care Development Agency, 2017; Federal Ministry of Health, 2019; World Food Programme, 2016). Most published MAM trials compare food products against each other, and when counselling-only arms are included, they receive limited analytical attention (Karakochuk et al., 2012; Nikièma et al., 2014). The quantitative magnitude of the gap between counselling-only and food-supplemented outcomes, documented visit-by-visit over a full intervention period in a West African trial, has not previously been reported. This evidence gap constrains evidence-based policy for Nigeria's estimated 3 million MAM-affected children.

This paper reports a four-arm randomised community trial in Ekiti State, Nigeria, with three specific objectives: (1) to characterise the complete fortnightly anthropometric trajectory of children managed with structured nutrition education alone across six bi-monthly visits over 90 days; (2) to quantify the progressive divergence between the NE arm and three food-supplemented arms in WHZ, MUAC, weight gain velocity, and secondary outcomes; and (3) to derive evidence-based programme and policy recommendations for Nigeria's national MAM management framework.

Methods

Trial Design, Setting, and Participants

Seventy-two children aged 6–59 months with confirmed MAM (WHZ −3 to −2; MUAC 11.5–12.5 cm; no bilateral pitting oedema) were enrolled from 18 PHC facilities across six Local Government Areas (LGAs) in the Ekiti South Senatorial District, Ekiti State, Nigeria. The district was selected because it recorded the highest MAM burden in the State (Ekiti State Primary Health Care Development Agency, 2017). Ethics approval was obtained from both the University of Nigeria, Nsukka (Ref: UN/ND/PG/M.Sc/Ph.D/16/80903) and from the Ekiti State PHCDA (Refs: EK/PHCDA/ADM/288/184; EK/PHCDA/ADM/288/185). This trial was not prospectively registered in a clinical trial registry; the authors acknowledge this as a limitation. Written informed consent was obtained from all caregivers in the Yoruba or Ekiti dialect before enrolment. Children were randomly allocated to four groups: PST (Plumpy Sup RUSF) (n=18), MSB (Maize-Soybean) (n=19), MPN (maize-peanut) (n=18), and NE (nutrition education) (n=18), using an investigator-blinded allocation technique in which sealed group assignments were prepared in advance and applied by study staff who were masked to the individual child's baseline measurements at the time of allocation. Because the supplementary foods differed visibly in form and packaging, full blinding of caregivers and field nutrition officers to group assignment was not feasible; the trial was therefore open-label for participants and intervention deliverers. However, anthropometric outcome assessors were not involved in food distribution and conducted measurements without knowledge of group allocation, providing assessor-level blinding for the primary outcomes.

Sample size and power justification. The initial sample size was estimated using the formula $N = 4P(1-P)/W^2$, where P is the prevalence of MAM in Ekiti State (3.5%; NNHS, 2018) and W is the required precision level (0.05), yielding N = 54. This was inflated by 30% to 72 to account for anticipated attrition and caregiver refusals, giving 18 participants per arm across four groups. For the primary continuous outcome (WHZ change), assuming a minimum clinically meaningful between-group difference of 0.5 WHZ units, within-group standard deviation of 0.5, $\alpha = 0.05$ (two-tailed), and 80% power, a minimum of 17 participants per group is required. Enrolment of 18–19 per arm exceeded this requirement.
For the primary binary outcome reported here, MAM recovery rate, a two-proportion Fisher's exact test detecting a 0% vs. 100% difference with $\alpha = 0.05$ and 80% power

requires only 8 participants per arm, less than half the enrolment achieved. The per-arm enrolment of 18, therefore, provided >95% power for this finding.

Interventions

All four groups received structured nutrition education and dietary counselling at each of six bi-monthly visits, delivered individually by trained nutrition officers in the Yoruba or Ekiti dialect using culturally appropriate visual aids. Sessions lasted 20–30 minutes and covered dietary diversity, age-appropriate feeding frequency, responsive feeding, food hygiene, and recognition of danger signs. The NE group received no food, food vouchers, or any material benefit, representing the maximum quality of counselling-based MAM management achievable in a Nigerian PHC setting, a ceiling estimate of standalone efficacy.

The three food-supplemented groups additionally received 14 sachets per semi-monthly visit: Plumpy Sup (PST; 92 g/sachet, 537 kcal/100g), locally formulated maize-soybean gruel (maize Soybean; 171.2 g/sachet, ~418 kcal/100g), or locally formulated maize-peanut gruel (maize peanut; 182 g/sachet, ~424 kcal/100g). This design isolates the clinical value of food: food-supplemented groups received food plus counselling; the NE group received counselling alone. Notably, PST delivered approximately 537 kcal/100g compared with ~418–424 kcal/100g for the locally formulated gruels, a roughly 28% higher energy density per gram.

Anthropometric Assessment and Outcome Definitions

Anthropometric measurements were taken at enrolment (Week 0) and again at each of six subsequent semi-monthly visits (Weeks 2, 4, 6, 8, 10, and 12). Weight was measured to 0.1 kg, height/length to 0.1 cm, and MUAC to 0.1 cm, all measurements taken in duplicate. WHZ, HAZ, and WAZ were calculated using WHO Anthro v3.2.2, based on the WHO Child Growth Standards (World Health Organization, 2006. MAM recovery was defined as WHZ > −2 and MUAC > 12.5 cm at the same assessment point. Weight gain velocity was calculated as [endline − baseline weight (g)] ÷ [mean body weight (kg) × 90 days] (Golden, 2009), with a minimum adequate response threshold of 1.0 g/kg/day (WHO, 2012).

Statistical Analysis

Data were analysed using SPSS v23.0 (IBM Corporation, Armonk, NY). Continuous outcomes are reported as means ± standard deviations (SD) with 95% confidence intervals (CIs) for key between-group differences. Effect sizes are reported as Cohen's d. Between-group differences were assessed by one-way ANOVA with Duncan's Multiple Range Test for post-hoc comparisons; within-group changes by paired t-tests; recovery rates by Fisher's exact test. Number Needed to Treat (NNT), and their 95% CIs were calculated using standard formulae. Completers at each visit were analysed; missing data were not imputed. An intention-to-treat (ITT) sensitivity analysis was not performed, given the categorical and absolute nature of the primary outcome (0% vs. 100% recovery); the binary result is invariant to the method of handling missing data, as no child in the NE group recovered at any visit regardless of attrition. The authors acknowledge the absence of a formal ITT analysis as a limitation, particularly for the continuous secondary outcomes.

Results

Baseline Characteristics

Table 1 presents baseline characteristics. The four groups were well-balanced at enrolment. Mean age was slightly, but not significantly, higher in the NE group. All 72 enrolled children across all four groups had MUAC within the confirmed MAM range (11.5–12.5 cm) at enrolment; the NE group baseline MUAC (11.84 ± 0.21 cm) was statistically comparable to the food-supplemented groups (range 11.78–11.85 cm; p = 0.543), confirming no statistically significant between-group differences at trial entry. Randomisation produced comparable groups; observed outcome differences are attributable to the intervention received.

Table 1. Baseline anthropometric characteristics by intervention group (means ± SD)

Characteristic	NE (n=18)	PST (n=18)	MSB (n=19)	MPN (n=18)
Age (months)	15.67±12.05	12.80±9.43	13.21±10.17	12.34±8.96
Weight (kg)	6.80±1.57	6.55±1.28	6.38±1.31	6.32±1.37
WHZ	−2.65±0.17	−2.70±0.19	−2.71±0.24	−2.72±0.23
MUAC (cm)	11.84±0.21	11.81±0.22	11.80±0.25	11.78±0.24
HAZ	−1.99±0.48	−2.01±0.53	−1.97±0.49	−2.03±0.51
WAZ	−3.00±0.38	−2.98±0.35	−3.02±0.41	−3.01±0.39
Sex (% male)	55.6%	50.0%	52.6%	55.6%

NE = Nutrition Education only; PST = Plumpy Sup RUSF; MSB = Maize-Soybean; MPN = Maize-Peanut. WHZ = weight-for-height z-score; MUAC = mid-upper arm circumference; HAZ = height-for-age z-score; WAZ = weight-for-age z-score. No significant between-group differences at baseline (all p > 0.05).

MAM Recovery Rate

The primary finding is categorical. Zero children in the NE group achieved MAM recovery (WHZ > −2 and MUAC > 12.5 cm) at any of the six assessment visits over 90 days (0/7 completers at Week 12; 0%; 95% CI: 0–41%). This zero-recovery rate was consistent across all visits; no child recovered at Week 2, 4, 6, 8, 10, or 12. In contrast, all food-supplemented completers at Week 12 achieved recovery: 13/13 PST, 15/15 MSB, 10/10 MPN (combined 38/38; 100%; p < 0.001 vs. NE by Fisher's exact test). The NNT = 1.0 — every child who received supplementary food and completed follow-up recovered; none who received counselling alone recovered. Key outcomes at Week 12 are summarised in Table 2.

The visit-by-visit trajectory data (Table 3) permit an assessment of the approximate timing of recovery across the three food-supplemented groups. No group met both recovery criteria (WHZ > −2 and MUAC > 12.5 cm) at the group mean level at Weeks 0, 2, or 4. By Week 6, mean WHZ and mean MUAC in both the PST (WHZ −1.65; MUAC 12.64 cm) and MSB (WHZ −1.91; MUAC 12.52 cm) arms had crossed both recovery thresholds, indicating that the majority of children in those arms had individually recovered by that

point. The MPN arm's mean MUAC remained marginally below 12.5 cm at Week 6 (12.49 cm) and crossed both thresholds at Week 8 (WHZ −1.67; MUAC 12.71 cm). From Week 8 onwards, group means in all three food-supplemented arms remained above both recovery thresholds, and all completers were individually confirmed recovered by Week 12 (PST 13/13; MSB 15/15; MPN 10/10). PST therefore achieved the earliest and steepest trajectory, consistent with its higher energy density (537 kcal/100g vs. ~418–424 kcal/100g for the local formulations); the total WHZ gain for PST (+2.46 units) exceeded that of MSB (+1.88) and MPN (+1.79) over 90 days. The NE group mean WHZ and MUAC never crossed either threshold at any visit.

Table 2. Key anthropometric outcomes at Week 12 by intervention group

Outcome (Week 12)	NE (n=7)	PST (n=13)	MSB (n=15)	MPN (n=10)
Recovery rate	0% (0/7)	100% (13/13)	100% (15/15)	100% (10/10)
WHZ (mean±SD)	−2.46 ± 0.19	−0.24 ± 0.31	−0.83 ± 0.28	−0.93 ± 0.30
ΔWHZ from baseline	+0.19	+2.46	+1.88	+1.79
MUAC (cm)	12.03 ± 0.22	13.57 ± 0.41	13.11 ± 0.38	12.98 ± 0.35
Weight gain velocity (g/kg/day)	0.20	2.29	1.78	1.71
WAZ change	−0.09	+0.76	+0.48	+0.30
p vs NE (WHZ)*	—	<0.001	<0.001	<0.001

*Between-group p-values by one-way ANOVA. The NE group WHZ at Week 12 remained within the moderate wasting range (WHZ −3 to −2); MUAC remained below the 12.5 cm recovery threshold. All food-supplemented completers exceeded both thresholds.

WHZ Trajectory and Progressive Divergence

Table 3 shows the visit-by-visit WHZ trajectory. The NE group's WHZ was essentially flat across all six visits, with a net gain of only +0.19 z-score units over 90 days, less than the gain achieved by any food-supplemented group in a single fortnight. All three food-supplemented groups showed consistent, substantial WHZ improvement at each visit: PST +2.46 units; MSB +1.88 units; MPN +1.79 units. The between-group WHZ gap widened monotonically at every visit: 0.15 z-score units at Week 2 ($p = 0.040$), 0.47 units at Week 4 ($p = 0.001$), 0.76 units at Week 6, 1.13 units at Week 8, 1.56 units at Week 10, and 1.88 units at Week 12 (all $p < 0.001$; 95% CI for WHZ difference at Week 12: 1.44–2.32 units; Cohen's $d = 4.31$). The significance of the divergence at Week 2 (when the drop-out rate was low – see Table 4) confirms that the biological advantage of food supplementation manifests within the first fortnight.

Table 3. WHZ values (mean ± SD) by intervention group at each visit, with between-group p-values

Visit	NE	PST	MSB	MPN	p-value
Week 0 (baseline)	−2.65 ± 0.17	−2.70 ± 0.19	−2.71 ± 0.24	−2.72 ± 0.23	0.861
Week 2	−2.59 ± 0.18	−2.37 ± 0.22	−2.41 ± 0.25	−2.44 ± 0.22	0.040
Week 4	−2.58 ± 0.19	−2.10 ± 0.24	−2.18 ± 0.28	−2.20 ± 0.26	0.001
Week 6	−2.60 ± 0.20	−1.79 ± 0.29	−1.91 ± 0.31	−1.94 ± 0.30	<0.001
Week 8	−2.60 ± 0.21	−1.38 ± 0.30	−1.52 ± 0.30	−1.55 ± 0.29	<0.001
Week 10	−2.51 ± 0.19	−0.82 ± 0.31	−1.15 ± 0.29	−1.21 ± 0.30	<0.001
Week 12	−2.46 ± 0.19	−0.24 ± 0.31	−0.83 ± 0.28	−0.93 ± 0.30	<0.001

p-values by one-way ANOVA at each time point. WHZ = weight-for-height z-score; NE = Nutrition Education only; PST = Plumpy Sup RUSF; MSB = Maize-Soybean; MPN = Maize-Peanut.

MUAC, Weight Gain Velocity, and Secondary Outcomes

Total MUAC gain in the NE group was 0.19 cm (+0.88%) over 90 days, compared with 1.19–1.76 cm in food-supplemented groups. The full visit-by-visit MUAC trajectory is presented in Table 4. A transient mid-trial MUAC decline for NE to 11.79 cm at Week 6 (from 11.84 cm at enrolment) indicates that without food supplementation, children could experience periods of slight further deterioration, not merely stagnation. Weight gain velocity in the NE group was 0.20 g/kg/day (95% CI: 0.09–0.31), 8.7% of the PST velocity (2.29 g/kg/day), and one-fifth of the minimum adequate response threshold of 1.0 g/kg/day. Absolute weight gain in the NE group was only 0.06 kg over 90 days, compared with 0.90–1.26 kg in food-supplemented groups. WAZ worsened in the NE group (−3.00 to −3.09; Δ = −0.09) while improving in all food-supplemented groups (Δ +0.30 to +0.76), confirming that counselling-only management does not prevent progressive divergence of weight-for-age from the reference standard.

Table 4. MUAC trajectory (mean ± SD, cm) by intervention group at each visit

Visit	NE	PST	MSB	MPN
Week 0 (n=18/19/18/18)	11.84 ± 0.21	11.76 ± 0.17	11.80 ± 0.23	11.85 ± 0.22
+Week 2 (n=14/15/18/16)	11.84 ± 0.23	12.01 ± 0.25	12.02 ± 0.26	12.00 ± 0.25
Week 4 (n=13/15/17/14)	11.81 ± 0.22	12.36 ± 0.17	12.30 ± 0.23	12.26 ± 0.25
Week 6 (n=9/14/17/12)	**11.79 ± 0.16↓**	12.64 ± 0.17	12.52 ± 0.17	12.49 ± 0.12
Week 8 (n=7/13/16/10)	11.87 ± 0.16	12.88 ± 0.13	12.72 ± 0.14	12.71 ± 0.10
Week 10 (n=7/13/16/10)	11.94 ± 0.14	13.08 ± 0.15	12.89 ± 0.14	12.82 ± 0.11
Week 12 (n=7/13/15/10)	12.03 ± 0.14	13.25 ± 0.18	13.07 ± 0.14	13.04 ± 0.13

↓ Denotes a transient decline below the enrolment value. NE = Nutrition Education only; PST = Plumpy Sup RUSF; MSB = Maize-Soybean; MPN = Maize-Peanut. The 12.5 cm MUAC recovery threshold is exceeded by all food-supplemented groups by Week 4 and maintained thereafter; the NE group remains below the threshold at all visits. N values listed as NE/PST/MSB/MPN.

Discussion

The absolute failure of structured nutrition education to produce any MAM recovery in this trial, despite individually delivered, linguistically appropriate, comprehensive counselling by trained nutrition officers over six visits, reflects a mechanistic reality: counselling alone cannot address it, at least within 90 days. MAM is a physiological state of energy and protein deficit requiring energy above maintenance requirements for catch-up growth, estimated at 150–200 kcal/kg/day compared with 90–120 kcal/kg/day for maintenance (Waterlow, 1992). The typical complementary diet in southwest Nigeria, cereal porridges, starchy vegetables, and minimal protein sources, provides approximately 60–80 kcal per 100 g of prepared food, far below the energy density required at child-appropriate feeding volumes even for well-nourished children (Dewey & Adu-Afarwuah, 2008). No quality of counselling can change this constraint when household food security is the binding limitation (Annan et al., 2014). The NE group's +0.19 WHZ gain over 90 days mirrors precisely the +0.19 WAZ pooled estimate from Bhutta et al.'s (2008) synthesis of 35 systematic reviews of counselling-only approaches in food-insecure settings, a cross-context consistency that strongly reinforces the generalisability of the finding. A potential counterargument merits acknowledgement: while NE produced no MAM recovery, it may be argued that it stabilised children and prevented progression to SAM. The NE group's mean WHZ improved marginally from −2.65 at baseline to −2.46 at Week 12 (+0.19 units), and no child in the NE group progressed to SAM (WHZ < −3) during the trial period. Compared with a hypothetical absence of any intervention, these observations suggest a residual stabilising effect of structured counselling. However, this interpretation must be qualified by three findings: first, a transient MUAC decline to 11.79 cm at Week 6 (Table 4) indicates that the trajectory was not uniformly stable; second, WAZ deteriorated from −3.00 to −3.09, reflecting continued weight-for-age divergence from the reference standard; and third, the absence of a true no-intervention control arm means this comparison is inferential rather than empirical. Accordingly, any stabilising effect of NE, while plausible and consistent with a harm-reduction framing, represents a minimum threshold of benefit, insufficient for clinical recovery and inadequate to justify counselling-only management as programmatic policy.

However, this is not to say that NE should not be included along with supplementation. It may have a long-term impact on recidivism. 'Nutrition education retains an important complementary role alongside food supplementation, not merely for immediate recovery but for preventing relapse to MAM following discharge, as caregivers equipped with knowledge of dietary diversity, feeding frequency, and responsive feeding are better positioned to sustain recovery gains (Lassi et al., 2013; Annan et al., 2014).

A critical design feature strengthens the generalisability of these results: the NE intervention represented the ceiling, not the floor, of counselling-based MAM management achievable in a Nigerian PHC setting. Sessions were individual (not group-based), delivered by trained nutrition officers (not community health workers), culturally and linguistically appropriate, comprehensive across eight IYCF domains, and conducted consistently at six contacts. If this quality of counselling produced zero recoveries in 18 enrolled children over 90 days, routine facility-level counselling, which meets none of these benchmarks, will also fail. Furthermore, the WHZ divergence between groups was statistically significant as early as Week 2 ($p = 0.040$) and widened at every subsequent visit, providing no clinical basis for a "wait-and-see" approach. Non-response escalation to food supplementation should be triggered within 2–4 weeks of first PHC contact, using thresholds such as MUAC gain < 0.3 cm or WHZ gain < 0.15 units over the first four-week period. A Type II error (false negative: failure to detect a real effect) is not a plausible explanation: the recovery rate difference is categorical and absolute (0% vs. 100%), statistically significant at every assessment point from Week 2 ($p = 0.040$) to Week 12 ($p < 0.001$), and the effect size (Cohen's $d = 4.31$ for WHZ at Week 12) exceeds any published threshold for a large effect ($d > 0.8$) by a factor of more than five.

Nutrition education retains an important role in MAM management, as a complement to food supplementation, not a substitute. All three food-supplemented groups also received the same structured counselling, and all achieved

100% recovery. Lassi et al. (2013) document that combined counselling and food supplementation produce superior child growth outcomes compared to food supplementation alone, reflecting their complementary mechanisms: food provides the substrate; counselling maximises how that substrate is used. The appropriate programme conclusion is therefore food supplementation plus nutrition education as the minimum standard of care, deployed together as a non-negotiable package.

The differential outcomes observed between PST and the locally formulated arms across visits may partly reflect the caloric gradient among these supplementary foods (PST: 537 kcal/100g vs. ~418–424 kcal/100g for the local formulations), as well as differences in micronutrient content: Plumpy Sup provides substantially higher levels of calcium (610 mg/100g), zinc (11 mg/100g), iron (12 mg/100g), and vitamin A (1020 µg RE/100g) compared with the locally formulated gruels (calcium 11.8–14.2 mg/100g; zinc 3.1–4.0 mg/100g; iron 4.8–5.5 mg/100g; vitamin A 1.1–1.2 µg RE/100g). The absence of any difference in recovery between MSB and MPN, despite their distinct ingredient profiles, suggests that both local formulations exceeded the minimum energy and macronutrient threshold required for MAM recovery in this context, and that catch-up growth over 90 days was primarily energy/protein-limited rather than micronutrient-limited, with the household diet likely compensating for micronutrient gaps equally across both local arms. However, a formal dose-response analysis across the four arms was not conducted; this is acknowledged as a limitation.

Nigeria's estimated 3 million MAM-affected children face a potential 90-day zero-recovery outcome under the current standard of care, which is for them to receive counselling-only management. With 10–20% at risk of SAM progression at three to five times the treatment cost (Lazzerini et al., 2013), this approach is both clinically indefensible and economically irrational. The present trial provides direct evidence that locally formulated maize-soybean and maize-peanut composite gruels achieve equivalent MAM recovery to commercial Plumpy Sup RUSF (100% in all three food-supplemented arms). Given that the raw ingredients, fermented maize, toasted soybean, and roasted peanut, are widely and cheaply available across south-west Nigeria, locally produced composite gruels of this type offer a substantially lower-cost implementation pathway than imported commercial RUSF, consistent with evidence from comparable trials in sub-Saharan Africa (LaGrone et al., 2012; LaGrone et al., 2010; Medoua et al., 2016; Stobaugh et al., 2021). Revision of Nigeria's national MAM management guidelines to mandate direct dietary supplementation as the minimum standard of care, together with nutrition counselling, is the clear, evidence-based policy imperative emerging from this trial.

Limitations

The NE group was reduced to n=7 at Week 12 by attrition from missed appointments, limiting the precision of continuous anthropometric estimates at endline. However, the 0% recovery rate was consistent across all earlier visits when sample sizes were larger, and the binary outcome was unaffected by this attrition. The trial was conducted in one senatorial district of south-west Nigeria; dietary context, food security patterns, and food systems in northern Nigeria, where MAM prevalence is substantially higher, may differ. The absence of a placebo food means the lack of food cannot be experimentally separated from the counselling content; however, this design replicates the operational reality of PHC-based counselling-only management, making it the most policy-relevant comparison available. Household food security was not formally measured at enrolment or during follow-up; variation in household food access could have acted as a residual confounding factor, particularly for the NE group, whose recovery depended entirely on improvements to the household diet. A formal intention-to-treat analysis was not performed, and this is acknowledged as a limitation for the interpretation of the secondary continuous outcomes. The trial was not prospectively registered in a public clinical trials registry, which limits transparency; ethical approval from two independent institutional review bodies was secured before enrolment. A CONSORT flow diagram is provided as a supplementary figure accompanying this manuscript.

Conclusions

This randomised community trial provides unambiguous evidence that structured nutrition education and dietary counselling, as the sole intervention for MAM-diagnosed children in a Nigerian PHC context, fail to produce clinical recovery within 90 days. None of the 18 enrolled children had recovered at any of the six assessment points over 90 days; weight gain velocity was one-fifth of the minimum adequate response threshold; and the WHZ divergence between the counselling-only and food-supplemented groups widened at every visit to a final Cohen's d of 4.31. This finding is not a consequence of insufficient sample size: the binary recovery outcome is categorical, consistent, and powered at >95% at the achieved enrolment. The minimum standard of care for MAM-diagnosed children in Nigeria must be direct dietary supplementation, accompanied by nutrition education, as a non-negotiable combined package. Locally formulated maize-based composite supplementary foods provide a cost-feasible mechanism for meeting this standard at the PHC level. Revision of national guidelines to mandate food supplementation for all MAM-diagnosed children is the evidence-based policy imperative that these findings support.

Author Contributions

RAA: Conceptualisation, Methodology, Investigation, Formal Analysis, Writing – Original Draft, Writing – Review & Editing. JUN: Conceptualisation, Supervision, Writing – Review & Editing. SAM: Formal Analysis, Methodology, Writing – Review & Editing. IO: Data Curation, Formal Analysis, Writing – Review & Editing. All authors read and approved the final manuscript. All authors then critically reviewed the following versions. All authors have read and approved the final version of the paper and its submission and have given consent for publication.

Ethics Approval and Consent to Participate

Ethics approval was obtained from the University of Nigeria, Nsukka (Ref: UN/ND/PG/M.Sc/Ph.D/16/80903) and the Ekiti State Primary Health Care Development Agency (Refs: EK/PHCDA/ADM/288/184; EK/PHCDA/ADM/288/185). Written informed consent was obtained from all caregivers before enrolment.

Declaration of Generative AI and AI-Assisted Technologies in Scientific Writing

The authors used AI-assisted writing tools (specifically Claude and Grammarly) to assist with language editing, phrasing, and manuscript preparation. All scientific content, data, analyses, and conclusions are entirely the work of the authors. The authors take full responsibility for the accuracy, integrity, and originality of the research reported. No AI tool was used to generate, fabricate, or analyse data.

Acknowledgements

The authors thank the staff of the Ekiti State Primary Health Care Development Agency, the Local Government Nutrition Focal Persons across the six study LGAs, and the caregivers and families who participated in the trial.

Data Availability Statement

De-identified data are available from the corresponding author upon reasonable request.

Funding

No external funding was received for this study.

Conflict of Interest

The authors declare no competing interests.

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