

Research Article

Growth Monitoring and Promotion Model Quality, Regularity of Utilisation, and Child Nutritional Outcomes in High-Burden Communities: Evidence from a Convergent Parallel Mixed-Methods Study in Sulima Chiefdom, Falaba District, Sierra Leone

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Keywords: Growth monitoring and promotion; Child undernutrition; Stunting; Sierra Leone; Mixed methods; Health belief model; IYCF counselling; Mother support groups; Rural health



Abstract

Background: Worldwide, an estimated 149 million children below the age of five are stunted and a further 45 million are wasted, with the heaviest concentration of this burden falling on Sub Saharan Africa. In Sierra Leone, where national stunting stands at 29% and climbs considerably higher across isolated northern districts, a pressing evidence gap remains that the existing cross-sectional literature has not resolved using rigorous multi-variable methods.

Methods: We carried out a convergent parallel mixed-methods study made up of (1) a community-based cross-sectional survey of 617 mother-child dyads and (2) twelve (12) key informant interviews (KIIs) examined through Framework Analysis in NVivo 14 ($\kappa = 0.82$). Fieldwork took place in Sulima Chiefdom, Falaba District, between January and March 2026. Anthropometric indices were derived from the WHO 2006 Child Growth Standards using the WHO Anthro (igrowup) macro, after which the computed z-scores were transferred to SPSS for analysis. Independent correlates of regular GMP attendance (≥ 4 sessions/6 months) were established through bivariable and multivariable logistic regression, while multiple linear regression isolated the independent contribution of GMP attendance to height-for-age z-score (HAZ) and weight-for-age z-score (WAZ). A formal mediation analysis with bootstrapped inference (5,000 resamples) examined the Knowledge-Attitude-GMP Attendance pathway, and Spearman's correlation was used to probe dose-response patterns.

Results: Regular GMP attendance reached 41.8% ($n = 258/617$), a level 36 percentage points below ever-attendance (77.8%). Stunting prevalence stood at 28.7% (95% CI: 25.1–32.3%) and global acute malnutrition (GAM) at 18.3% (95% CI: 15.3–21.4%), surpassing the WHO emergency threshold. Children attending regularly showed markedly less stunting (19.0% vs. 35.7%; OR = 0.42, 95% CI: 0.29–0.62) and a mean HAZ that was 0.49 SD higher (Cohen's $d = 0.41$, $p < 0.001$). Within the multivariable linear model, regular attendance held as an independent predictor of HAZ ($\beta = 0.365$, SE = 0.102, $p < 0.001$) and WAZ ($\beta = 0.343$, SE = 0.095, $p < 0.001$) once 11 covariates were taken into account. IYCF counselling (aOR = 4.20), positive attitude (aOR = 3.72), mother support group membership (aOR = 1.87), and perceived benefit (aOR = 1.79) each independently predicted regular attendance, whereas maternal knowledge lost significance entirely (aOR = 1.23, $p = 0.807$). Mediation analysis indicated that attitude carried an estimated 25.3% of the knowledge-attendance association (indirect effect $a \times b = 0.048$; bootstrap 95% CI: 0.023–0.079). Dose-response patterns showed stunting falling steadily from 32.5% at zero sessions to 13.3% at six ($p = 0.170$, $p < 0.001$). The qualitative data supplied convergent mechanistic support for each quantitative result.

Conclusion: GMP participation shows an independent and significant association with stronger child linear growth and ponderal status in one of Sierra Leone's most underserved settings. The modifiable levers that matter are not individual knowledge but attitudinal, relational, and structural ones: quality service encounters that cultivate a positive attitude, IYCF counselling that fosters purposeful engagement, social capital generated through mother support groups, and physical accessibility. Taken together, the results argue that programmes should consider shifting away from attendance registration toward quality-centred integrated service delivery, reinforced by community mobilisation and satellite GMP infrastructure serving distant populations.



Background

Childhood undernutrition stands among the most enduring public health challenges of the present century. According to the World Health Organization, roughly 149 million children under five are stunted, some 45 million are wasted, and more than 39 million carry excess weight—a triple burden that falls disproportionately on low- and middle-income countries (LMICs) [1]. UNICEF attributes more than 45% of all under-five deaths worldwide to undernutrition in its several forms, with those who survive carrying lasting consequences that include compromised neurocognitive development, weaker educational outcomes, and lower productivity in adulthood [2]. A disproportionate share of this burden rests on Sub-Saharan Africa, which is home to roughly 40% of the world's stunted children and to some of the highest rates of acute malnutrition anywhere [3,4].

Growth Monitoring and Promotion (GMP)—the periodic measurement of a child's anthropometric indices at set intervals, paired with caregiver counselling and referral—is widely endorsed as a high-priority preventive activity within the Essential Nutrition Actions framework [5]. Its conceptual basis lies in detecting growth faltering early, before lasting harm sets in, so that corrective steps can follow without delay [6]. Delivered with quality and consistency, GMP operates at once as a surveillance mechanism, a delivery platform for vitamin A supplementation and immunisation, and a recurring point of contact for behaviour change. Studies from South Asia and sub-Saharan Africa report that children who attend GMP regularly show reduced odds of severe undernutrition, greater dietary diversity, and better maternal health literacy [7,8].

This study is grounded theoretically in the Health Belief Model [9], which holds that health-seeking behaviour is propelled less by information than by perceived susceptibility, perceived severity, perceived benefits of acting, perceived barriers, and cues to action. The model shaped the selection of attitudinal, perceived-benefit, and barrier variables in the quantitative strand and supplies the conceptual scaffolding for interpreting why attitude, rather than knowledge, surfaced as the leading proximal determinant of GMP attendance. The HBM has been usefully applied across GMP and child nutrition research in sub-Saharan Africa [10,11], and the present work extends this literature through formal mediation analysis and qualitative investigation of mechanism.

Sierra Leone offers one of West Africa's most demanding nutritional contexts. A prolonged civil war (1991–2002), the 2014–2016 Ebola outbreak, and the COVID-19 pandemic have together worn away health infrastructure, public confidence in health services, and workforce capacity [12]. The Sierra Leone Demographic and Health Survey 2019 (SLDHS 2019) put national stunting at 29%, wasting at 8%, and underweight at 12%—each above WHO high-concern thresholds and each

marked by pronounced north–south and rural–urban gaps [13]. Falaba District, in the remote Northern Province, records substantially higher figures; although GMP is formally written into the national Basic Package of Essential Health Services (BPEHS) and mandated through peripheral health units, uptake stays well short of programme targets [14].

The research gap and justification

A critical evidence gap remains despite this policy architecture. Work from Sierra Leone and comparable settings tends to report GMP coverage or nutritional outcomes separately; very little quantifies the dose-response link between the quality of GMP attendance and anthropometric outcomes while at the same time pinning down independent determinants through multivariable inference. Treating 'ever attended' as equivalent to 'regularly attended' has masked the programme-level signal: it is not contact alone but quality, regularity, and integrated delivery that translate into measurable nutritional gain. Compounding this, studies frequently single out knowledge as the chief modifiable lever without sufficient adjustment for attitudinal, social-network, and healthsystem structural factors, generating recommendations anchored in health education that do little to move population-level utilisation [10].

Sulima Chiefdom lies within Falaba District in Sierra Leone's remote Northern Province and was deliberately chosen for its long-running yet under-evaluated GMP programme, its documented high burden of child malnutrition, and the total lack of prior community-level GMP evidence from the area. The study tackles three specific gaps: (1) the missing community-level evidence on GMP utilisation patterns and nutritional outcomes in Sulima Chiefdom, among Sierra Leone's most geographically isolated and nutritionally exposed communities; (2) the absence of multivariable inference on the determinants of regular—as opposed to merely ever—GMP attendance, accounting for the full socio-ecological determinant space, including health-system and socialnetwork factors; and (3) the need to quantify, via linear regression, the independent effect of GMP attendance on anthropometric z-scores, yielding effect sizes that health-economic analysis and investment decisions require. To the authors' knowledge, this is the first community-level, mixedmethods study from Sulima Chiefdom to address all three gaps at once.

Materials and methods

Study design and setting

The study adopted a convergent parallel mixed-methods design [15], combining a community-based cross-sectional survey (quantitative strand) with key informant interviews analysed through Framework Analysis (qualitative strand). Both strands engaged the same phenomenon—GMP utilisation and child nutritional outcomes—from complementary epistemological vantage points: the quantitative strand



establishes what is occurring (prevalence, effect sizes, odds ratios), while the qualitative strand accounts for why and how it occurs. The two strands were gathered at the same time (January–March 2026) in Sulima Chiefdom, Falaba District, Northern Province, Sierra Leone, analysed separately, and brought together at interpretation through a joint display matrix.

Sulima Chiefdom is geographically remote, marked by poor road links, seasonal flooding that can cut communities off for up to 3–4 months each year, low adult literacy (especially among women), and few functional health facilities given its population. This socioeconomic and epidemiological profile broadly mirrors rural Falaba District and comparable communities across Sierra Leone's Northern Province, which supports the transferability of the findings.

Quantitative strand: sample size and sampling

A sample of 617 was calculated with the Cochran formula for cross-sectional surveys. Because no dependable prior estimate of regular GMP attendance existed for Sulima Chiefdom, a prevalence of 50% was assumed to maximise the required sample, together with a 5% margin of error, a 95% confidence level, and a 10% allowance for non-response. Sampling proceeded in two stages: villages and communities were drawn by probability proportional to size (PPS) in Stage 1, and in Stage 2 households containing at least one child aged 0–59 months were chosen by systematic random sampling. When a household held more than one eligible child, a single index child was selected at random using the Kish grid to guard against selection bias.

Data collection

Trained enumerators administered a structured questionnaire spanning five domains: (A) maternal socio-demographic characteristics; (B) child characteristics and health history; (C) GMP utilisation history and programme quality indicators; (D) maternal knowledge, attitude, and perception concerning GMP and child nutrition; and (E) household and health-system factors, including barriers to service access and contacts with community health workers. Anthropometric measurements—weight (kg), recumbent length or standing height (cm), and MUAC (mm)—were taken in triplicate following WHO standard operating procedures, with the median value retained. Weight was read to the nearest 0.1 kg on a calibrated electronic/Salter scale, length or height to the nearest 0.1 cm on a standard WHO-recommended (UNICEF-type) wooden board, and MUAC to the nearest 1 mm; all instruments were calibrated each day. Household food insecurity was captured with the Household Food Insecurity Access Scale (HFIAS). Z-scores were generated from the WHO 2006 [16] Child Growth Standards using the WHO Anthro (igrowup) macro and are reported to two decimal places.

Outcome Variables and Definitions

The primary outcome was regular GMP attendance,

defined as attending ≥ 4 GMP sessions during the six months before the survey—in keeping with WHO monthly session protocols—and coded as binary (Yes/No). Secondary outcomes comprised Height-for-Age Z-score (HAZ), Weight-for-Age Z-score (WAZ), and Weight-for-Height Z-score (WHZ). Clinical cut-offs followed WHO standards: stunting (HAZ < -2 SD), wasting (WHZ < -2 SD), underweight (WAZ < -2 SD), moderate acute malnutrition (MAM: MUAC 115–124 mm), and severe acute malnutrition (SAM: MUAC < 115 mm). Global Acute Malnutrition (GAM) was taken as SAM plus MAM.

Quantitative statistical analysis

Analyses were run in IBM SPSS Statistics (Version 26.0; IBM Corp., Armonk, NY, USA). Continuous variables were summarised as mean $\pm$ standard deviation (SD) where normally distributed (judged by the Shapiro–Wilk test) or as median (interquartile range) otherwise. Categorical variables were reported as frequencies and percentages with 95% Wilson confidence intervals.

Crude odds ratios (cOR) with 95% CIs for each candidate predictor of regular GMP attendance were obtained from bivariable logistic regression. Predictors meeting $p < 0.25$ in bivariable analysis, along with those of established programmatic relevance, were entered into the multivariable model by forced entry (Enter method), favoured over stepwise selection for confirmatory inference. Model fit was checked using the Hosmer–Lemeshow goodness-of-fit test (adequate fit: $p > 0.05$) and Nagelkerke R^2 . Multicollinearity was screened with the variance inflation factor (VIF; all VIFs < 5.0). Because the survey used two-stage cluster sampling, the possibility of intracluster correlation was considered; to protect against underestimated standard errors, robust (cluster-aware) variance estimation was applied to the regression models with the village/community as the clustering unit. Results were essentially unchanged relative to models assuming independent observations, though residual design effects cannot be entirely excluded and are discussed further under Limitations.

Multiple linear regression used HAZ and WAZ as dependent variables, adjusting simultaneously for 11 covariates chosen a priori from the conceptual framework and from established determinants of child growth in the literature: child age, sex, birth weight, exclusive breastfeeding, diarrhoea in the previous two weeks, ARI in the previous two weeks, vitamin A supplementation, maternal knowledge category, household food security, IYCF counselling exposure, and distance to the primary health centre. Regression coefficients (β) are unstandardised and express the change in zscore (in SD units) per unit change in the predictor.

Mediation analysis examined the hypothesised Knowledge→Attitude→GMP Attendance pathway using a bootstrapping approach to the indirect effect (5,000 resamples; percentile method), with the Baron and Kenny



(1986) [17] causal-steps logic reported descriptively for transparency. Because the data are cross-sectional and the temporal ordering of knowledge, attitude, and attendance cannot be fixed by design, all mediation results are read as exploratory and hypothesis-generating rather than as confirmation of a causal sequence. This was supplemented by a moderation (interaction) analysis testing whether the knowledge–attendance association varies with attitude.

Spearman's rank correlation (ρ) assessed associations among non-normal continuous variables and dose-response relationships. Statistical significance was set at $p < 0.05$ (two-tailed); borderline trends at $p < 0.10$ are flagged where pertinent.

Qualitative Strand

Twelve KIIs were conducted purposively across eight informant categories: Peripheral Health Unit (PHU) In-Charge ($n = 1$), Community Health Workers or CHWs ($n = 2$), CHW Peer Supervisor ($n = 1$), Mother Support Group Leader ($n = 1$), Community Leader ($n = 1$), Mothers spanning the attendance spectrum—regular, irregular, non-attender ($n = 4$), Chiefdom Nutrition Officer ($n = 1$), and Grand Mother Leader ($n = 1$). The sample reached thematic saturation: the last two interviews (KII-11, KII-12) surfaced no new themes or sub-codes, confirming saturation in line with published guidance on KII-based research in low-resource health-system settings [18,19]. Interviews were audio-recorded, transcribed verbatim, backtranslated for accuracy, and analysed with Framework Analysis [20] in NVivo 14 [21]. Inter-coder reliability was $\kappa = 0.82$ (mean across a 30% subsample), denoting strong agreement. The qualitative strand was reported following the Consolidated Criteria for Reporting Qualitative Research [22].

Mixed-methods integration

Quantitative and qualitative findings were integrated at the interpretation phase through a joint display matrix (Table 6), within which each quantitative result is set alongside its corresponding qualitative theme, mechanistic explanation, and direction of convergence. This strategy follows recommended practice for convergent parallel mixed-methods designs [15].

Ethical considerations

Ethical clearance was granted by the Institutional Review Board of Njala University and by the Sierra Leone Ethics and Scientific Review Committee. Written informed consent was secured from every participant before data collection. Participation was voluntary, and confidentiality was protected through anonymisation of the data. Any child found to have SAM during anthropometric screening was referred at once to the nearest Community-based Management of Acute Malnutrition (CMAM)-capable facility.

Results

Sample characteristics

In total, 617 mother–child dyads were enrolled, meeting

Table 1: Sociodemographic and Clinical Characteristics of Study Participants by GMP Attendance Status, Sulima Chiefdom, Sierra Leone (N=617).

Characteristic	n	% (95% CI)	Regular GMP %	Irregular GMP %
Maternal socio-demographics				
Maternal age group				
15–19 years	87	14.1 (11.5–17.1)	38.0	62.0
20–24 years	235	38.1 (34.3–42.0)	44.3	55.7
25–29 years	158	25.6 (22.2–29.3)	42.4	57.6
≥30 years	137	22.2 (19.0–25.8)	37.2	62.8
Marital status				
Married / cohabiting	428	69.4 (65.6–73.0)	43.9	56.1
Single / separated / widowed	189	30.6 (27.0–34.4)	36.5	63.5
Maternal education level				
No formal education	279	45.2 (41.3–49.2)	35.1	64.9
Primary education	181	29.3 (25.8–33.2)	44.2	55.8
Secondary education	127	20.6 (17.5–24.1)	50.4	49.6
Tertiary education	30	4.9 (3.4–7.0)	56.7	43.3
Monthly household income				
<500 SLL (<US\$25)	273	44.2 (40.3–48.2)	35.2	64.8
500–999 SLL	198	32.1 (28.4–36.0)	44.4	55.6
≥1,000 SLL (≥US\$50)	146	23.7 (20.4–27.3)	51.4	48.6
Residence type				
Village (rural)	448	72.6 (69.0–76.0)	38.6	61.4
Township / peri-urban	169	27.4 (24.0–31.0)	49.7	50.3
Household food security				
Food secure	111	18.0 (15.1–21.3)	55.0	45.0
Mildly food insecure	194	31.4 (27.8–35.3)	46.4	53.6
Moderately food insecure	214	34.7 (31.0–38.6)	38.8	61.2
Severely food insecure	98	15.9 (13.2–19.0)	30.6	69.4
Child characteristics				
Child sex: Male	336	54.5 (50.5–58.4)	41.4	58.6
Child age group				
0–11 months	145	23.5 (20.3–27.1)	52.4	47.6
12–23 months	174	28.2 (24.7–32.0)	43.7	56.3
24–35 months	138	22.4 (19.1–25.9)	39.9	60.1
36–47 months	96	15.6 (12.9–18.7)	33.3	66.7
48–59 months	64	10.4 (8.2–13.1)	28.1	71.9
Low birth weight (<2.5 kg)	87	14.1 (11.5–17.1)	31.0	69.0
Exclusive breastfeeding (6 months)	158	25.6 (22.3–29.3)	51.3	48.7
Full vaccination (age-appropriate)	320	51.9 (47.9–55.8)	47.5	52.5
Diarrhoea in past 2 weeks	149	24.1 (20.9–27.7)	35.6	64.4
ARI in past 2 weeks	98	15.9 (13.2–19.0)	37.8	62.2
Vitamin A supplementation (current)	312	50.6 (46.6–54.6)	48.1	51.9

Note: SLL = Sierra Leonean Leone; ARI = Acute Respiratory Infection; CI = Confidence Interval. GMP attendance: Regular = ≥4 sessions/6 months; Irregular = <4 sessions/6 months, which combines infrequent attendees and never-attenders into a single comparison group (see Limitations).

the target sample at a response rate of 97.3% (Table 1). Most mothers were married or cohabiting (69.4%), fell in the 20–24 year age band (38.1%), and lived in villages (72.6%). More than 76% of households reported a monthly income under 1,000 SLL (< US\$50), and 44.2% sat below 500 SLL, signalling deep economic vulnerability. No formal education was reported by 45.2% of mothers, while just 4.9% had completed tertiary

education. Household food insecurity was almost universal: only 18.0% of households were food secure, and 15.9% were severely food insecure. Children were split roughly evenly by sex (54.5% male), and low birth weight was recorded in 14.1% ($n = 87$). Exclusive breastfeeding to the recommended six months was reported by only 25.6% of mothers, below both national and WHO targets. Full vaccination coverage stood at 51.9% ($n = 320$), assessed among children aged ≥ 12 months who were old enough to have completed the national immunisation schedule.

GMP utilisation

Among the 617 children, 480 (77.8%, 95% CI: 74.5–81.1%) had attended a GMP session at some point. Regular attendance, however—defined as ≥ 4 sessions over the previous six months—was considerably lower, at 41.8% ($n = 258$, 95% CI: 37.9–45.7%). Continuity of GMP participation from birth was sustained in just 43.1% ($n = 266$). Of those who attended, 64.3% received nutrition counselling, 55.4% received a growth-chart explanation, and 64.0% had a child health immunisation card on hand. These numbers reveal a pronounced quality shortfall: barely 64.3% of attendees were counselled and only 55.4% had their growth chart explained, even though growth-chart explanation is the minimum activity expected at every GMP contact. The 36 percentage-point gap separating ever-attendance (77.8%) from regular attendance (41.8%) is a central programmatic finding of this study, indicating that while awareness of GMP is widespread in the community, sustained and good-quality engagement remains the decisive unmet target.

Nutritional status

Nutritional status indicators for the full sample appear in Table 2. Overall stunting prevalence was 28.7% (95% CI: 25.1–32.3%), above the WHO 20% threshold for high public health concern and closely matching the SLDHS 2019 national figure of 29%. GAM prevalence reached 18.3% (95% CI: 15.3–21.4%), surpassing the WHO emergency threshold of 15% and pointing to a nutrition emergency. Wasting affected 8.1% of children (beyond the WHO critical threshold of 5%), with underweight at 22.4%, SAM at 1.0%, and MAM at 18.2%. Mean

anthropometric z-scores were HAZ -1.30 ± 1.23 , WAZ -1.13 ± 1.12 , and WHZ -0.51 ± 1.07 .

Stunting in this sample rose with child age, peaking in the 36–47-month band (36.5%), in keeping with the cumulative toll of growth faltering across the complementary feeding transition. Mean HAZ fell from -0.87 among 0–5-month infants to -1.47 by 48–59 months—a trajectory implying that roughly 0.60 SD of linear growth potential is forfeited between early infancy and the close of the under-five period in this community [7].

Association between GMP attendance and nutritional status

The link between regular GMP attendance and nutritional outcomes held steady across every anthropometric indicator (Table 3). Stunting prevalence was 19.0% among regular attendees against 35.7% among irregular attendees (OR = 0.42, 95% CI: 0.29–0.62, $p < 0.001$)—close to a halving of stunting risk. GAM prevalence was 14.0% versus 21.4% (OR = 0.59, 95% CI: 0.39–0.92, $p = 0.023$). Wasting stood at 4.7% in regular attendees versus 10.6% in irregular attendees (OR = 0.41, 95% CI: 0.21–0.81, $p = 0.012$). Underweight affected 17.8% of regular versus 25.6% of irregular attendees (OR = 0.63, 95% CI: 0.42–0.94, $p = 0.028$).

Differences in the continuous anthropometric z-scores were both statistically significant and clinically meaningful. Regular GMP attendees recorded a mean HAZ of -1.01 (SD = 1.20) against -1.50 (SD = 1.21) among irregular attendees (mean difference: $+0.493$ SD; $t[615]=5.01$, $p < 0.001$; Cohen’s $d = 0.41$ —a moderate effect). The corresponding WAZ difference was $+0.355$ SD (Cohen’s $d = 0.32$) and the WHZ difference $+0.407$ SD (Cohen’s $d = 0.39$).

A dose-response relationship between GMP session frequency and nutritional status was confirmed. Stunting prevalence declined steadily from 32.5% at zero sessions to 13.3% at six sessions in the preceding six months, while mean HAZ improved in parallel from -1.49 to -0.72 . Spearman’s correlation confirmed a significant positive association between GMP visit frequency and HAZ ($\rho = 0.170$, $p < 0.001$)

Table 2: Nutritional Status of Children Under Five Years, Sulima Chiefdom, Sierra Leone (N = 617).

Nutritional Indicator	n	Prevalence %	95% CI (%)	WHO Threshold
Stunting (HAZ < -2 SD)	177	28.7	25.1–32.3	$>20\%$: high public health concern
Wasting (WHZ < -2 SD)	50	8.1	6.0–10.3	$>5\%$: critical threshold
Underweight (WAZ < -2 SD)	138	22.4	19.1–25.7	$>20\%$: high public health concern
Global Acute Malnutrition (GAM)	113	18.3	15.3–21.4	$>15\%$: Nutrition Emergency ★
Moderate Acute Malnutrition (MAM)	112	18.2	15.1–21.2	MUAC 115–124 mm
Severe Acute Malnutrition (SAM)	6	1.0	0.2–1.7	MUAC <115 mm
	Mean $\pm$ SD			Reference
Height-for-Age Z-score (HAZ)	-1.30 ± 1.23			0.00 (WHO median)
Weight-for-Age Z-score (WAZ)	-1.13 ± 1.12			0.00 (WHO median)
Weight-for-Height Z-score (WHZ)	-0.51 ± 1.07			0.00 (WHO median)
Mid-Upper Arm Circumference (MUAC, mm)	131.8 ± 7.6			≥ 125 mm: normal

Note: HAZ = Height-for-Age Z-score; WAZ = Weight-for-Age Z-score; WHZ = Weight-for-Height Z-score; MUAC = Mid-Upper Arm Circumference; SD = Standard Deviation. ★ GAM $\geq 15\%$ denotes a nutrition emergency per WHO/UNHCR standards.



Table 3: Association Between Regular GMP Attendance and Child Nutritional Outcomes, Sulima Chiefdom (N = 617).

Outcome	Regular attendees (n = 258)	Irregular Attendees (n = 359)	Crude OR / Mean Diff.	95% CI	p-value
Binary outcomes (Prevalence %)					
Stunting (HAZ <-2 SD)	19.0%	35.7%	OR = 0.42	0.29-0.62	<0.001
Wasting (WHZ <-2 SD)	4.7%	10.6%	OR = 0.41	0.21-0.81	0.012
Underweight (WAZ <-2 SD)	17.8%	25.6%	OR = 0.63	0.42-0.94	0.028
Global Acute Malnutrition	14.0%	21.4%	OR = 0.59	0.39-0.92	0.023
Continuous outcomes (Mean z-score ± SD)					
HAZ (mean ± SD)	-1.01 ± 1.20	-1.50 ± 1.21	+0.49 SD (d = 0.41)	—	<0.001†
WAZ (mean ± SD)	-0.92 ± 1.09	-1.28 ± 1.11	+0.36 SD (d = 0.32)	—	<0.001†
WHZ (mean ± SD)	-0.27 ± 1.03	-0.68 ± 1.07	+0.41 SD (d = 0.39)	—	<0.001†

Note: OR = Odds Ratio; CI = Confidence Interval; d = Cohen's d effect size. †Independent samples t-test. All tests two-tailed; significance at $p < 0.05$. Regular attendance = ≥ 4 sessions/6 months; Irregular attendance = < 4 sessions/6 months.

and WAZ ($\rho = 0.121$, $p = 0.003$), supplying dose-response evidence consistent with a causal interpretation.

Linear regression: Independent effect of GMP on anthropometric z-scores

In multiple linear regression adjusting for 11 covariates (child age, sex, birth weight, exclusive breastfeeding, recent diarrhoea and ARI, vitamin A supplementation, maternal knowledge, household food security, IYCF counselling, and distance to PHC; $n = 617$), regular GMP attendance held as a significant and independent predictor of HAZ ($\beta = 0.365$, $SE = 0.102$, 95% CI: 0.165–0.564, $p < 0.001$) and WAZ ($\beta = 0.343$, $SE = 0.095$, 95% CI: 0.157–0.529, $p < 0.001$). The dose-response estimate reinforces this: each additional GMP visit per six months was independently associated with a 0.091 SD gain in HAZ ($\beta = 0.091$, $SE = 0.038$, $p = 0.018$) and a 0.633 mm increase in MUAC ($\beta = 0.633$, $SE = 0.241$, $p = 0.009$).

The HAZ model accounted for 10.0% of the variance ($R^2 = 0.100$, Adjusted $R^2 = 0.081$, $F(11, 605) = 6.11$, $p < 0.001$). Although the explained variance is modest—reflecting considerable residual variation tied to factors not captured in this cross-sectional design—the GMP attendance coefficient is robust across model specifications. Good maternal knowledge was independently associated with a +0.566 SD higher HAZ ($\beta = 0.566$, $SE = 0.163$, $p < 0.001$) relative to poor knowledge after adjusting for GMP attendance, implying that knowledge acts on nutritional status through pathways partly independent of GMP participation, including home dietary practices. Child age was negatively associated with HAZ ($\beta = -0.010$, $SE = 0.003$,

$p < 0.001$), confirming the age-related build-up of chronic undernutrition. Full regression results appear in Table 4.

Determinants of regular GMP attendance: bivariable and multivariable analysis

In bivariable logistic regression, maternal knowledge, attitude toward GMP, perceived benefit, IYCF counselling, and mother support group membership were all strongly associated with regular GMP attendance (all $p < 0.001$). The multivariable logistic regression model identified six independent predictors after full adjustment (Table 5; Hosmer–Lemeshow $p = 0.331$; Nagelkerke $R^2 = 0.211$):

IYCF counselling through any channel versus none (aOR = 4.20, 95% CI: 1.40–12.63, $p = 0.010$): mothers who received IYCF counselling via community health workers, antenatal contacts, or community sessions were roughly four times as likely to attend GMP regularly, independent of knowledge, attitude, and social capital.

Positive attitude toward GMP versus negative (aOR = 3.72, 95% CI: 1.53–9.08, $p = 0.004$): the strongest retained attitudinal predictor, underscoring the primacy of demand generation through quality service encounters. Mother support group membership versus non-member (aOR = 1.87, 95% CI: 1.30–2.68, $p < 0.001$): the most precisely estimated predictor in the model, reflecting the role of peer social capital. Medium perceived benefit of GMP versus low (aOR = 1.79, 95% CI: 1.11–2.89, $p = 0.018$): a Health Belief Model construct operating through a distinct perceptual pathway. Single marital status versus married (aOR = 0.57, 95% CI: 0.35–0.93, $p = 0.024$):

Table 4: Multiple Linear Regression: Independent Effect of GMP Attendance on Anthropometric Z-Scores (N = 617).

Predictor variable	B (HAZ)	SE	p (HAZ)	B (WAZ)	SE	95% CI (HAZ)
Regular GMP attendance (Yes vs No)	0.365	0.102	<0.001	0.343	0.095	0.165 to 0.564
GMP visits (continuous, per visit)	0.091	0.038	0.018	0.076	0.035	0.016 to 0.167
Good maternal knowledge (vs. poor)	0.566	0.163	<0.001	0.412	0.151	0.247 to 0.886
Child age (per month)	-0.010	0.003	<0.001	-0.009	0.003	-0.016 to -0.004
Exclusive breastfeeding (Yes vs No)	0.189	0.087	0.031	0.143	0.081	0.018 to 0.360
Diarrhoea past 2 weeks (Yes vs No)	-0.221	0.095	0.020	-0.198	0.088	-0.408 to -0.034
Household food insecurity (secure vs severe)	0.312	0.128	0.015	0.287	0.119	0.061 to 0.564

HAZ Model: $R^2 = 0.100$, Adjusted $R^2 = 0.081$, $F(11, 605) = 6.11$, $p < 0.001$ | WAZ Model: $R^2 = 0.089$, Adjusted $R^2 = 0.070$, $F(11, 605) = 5.37$, $p < 0.001$ | N = 617 complete cases.
Note: B = unstandardised regression coefficient (change in z-score, in SD units, per unit change in predictor); SE = Standard Error. All models adjusted simultaneously for all listed covariates. HAZ = Height-for-Age Z-score; WAZ = Weight-for-Age Zscore; ARI = Acute Respiratory Infection.



Table 5: Independent Predictors of Regular GMP Attendance: Multivariable Logistic Regression (N = 617).

Variable	cOR	aOR	95% CI (aOR)	p - value	Interpretation
Demand-side attitudinal & relational predictors (Positive predictors)					
IYCF counselling (any channel) vs. none	7.52	4.20 ★	1.40–12.63	0.010	Retained; largest independent predictor
Positive attitude toward GMP vs. negative	6.39	3.72 ★	1.53–9.08	0.004	Retained; attenuated from crude but dominant
Mother support group membership vs. non-member	1.91	1.87 ★	1.30–2.68	<0.001	Most precisely estimated predictor
Medium perceived GMP benefit vs. low	3.00	1.79 ★	1.11–2.89	0.018	Health Belief Model: perceived benefit pathway
Structural & negative predictors					
Single marital status vs. married	0.64	0.57 ★	0.35–0.93	0.024	43% lower odds; social isolation mechanism
Distance to PHC (per additional km)	0.94	0.92 ★	0.85–0.99	0.026	8% reduction/km; unmasked by adjustment
Attenuated predictors (Non-significant after adjustment)					
Good maternal knowledge vs. poor	4.72	1.23 ×	0.24–6.32	0.807	Fully attenuated; mediated by attitude & IYCF
Neutral attitude toward GMP vs. negative	2.14	1.49 †	0.98–2.26	0.062	Borderline trend

Model fit: Hosmer–Lemeshow goodness-of-fit $p = 0.331$ (adequate fit); Nagelkerke $R^2 = 0.211$; Overall classification accuracy = 65.2%; N = 617. cOR = Crude Odds Ratio; aOR = Adjusted Odds Ratio. ★ $p < 0.05$ (significant); † $p < 0.10$ (borderline trend); × non-significant after adjustment.

a 43% reduction in odds. Distance to PHC per additional kilometre (aOR = 0.92, 95% CI: 0.85–0.99, $p = 0.026$): this variable was unmasked by multivariable adjustment (crude $p = 0.065$), implying its effect had been confounded by residence type. Critically, maternal knowledge was fully attenuated to non-significance (aOR = 1.23, $p = 0.807$), a finding with major programmatic implications.

Mediation analysis: the knowledge–attitude–attendance pathway

Exploratory mediation analysis was consistent with partial mediation of the knowledge–attendance association through attitude. Path a (Knowledge→Attitude): $B = 0.045$, $SE = 0.010$, $t = 4.41$, $p < 0.001$. Path b (Attitude→GMP visits, controlling for knowledge): $B = 1.078$, $p < 0.001$. Total effect (c): $B = 0.190$, $p < 0.001$; direct effect (c'): $B = 0.142$, $p < 0.001$. The indirect effect (a×b) was 0.048 (bootstrap 95% CI: 0.023–0.079; based on 5,000 resamples), excluding zero. The share of the total effect estimated as mediated through attitude was 25.3%. For the binary outcome (regular attendance), a positive attitude was associated with 2.6 times higher odds (OR = 2.631, $p = 0.0002$), and the bootstrapped indirect effect likewise excluded zero (95% CI: 0.017–0.080). These results are consistent with knowledge being associated with attendance both directly and indirectly (via attitude), with the attitudinal pathway appearing to be the dominant correlate—a pattern in line with the Health Belief Model's emphasis on perceived benefit over informational content. Given the cross-sectional design, the assumed Knowledge→Attitude→Attendance ordering cannot be verified, and these estimates should be read as exploratory.

A significant negative interaction between knowledge and attitude ($B = -0.122$, $p = 0.015$) was also detected, indicating that the marginal association between additional knowledge and GMP visits is smaller when attitude is already positive—a ceiling effect consistent with attitude functioning as the dominant proximal correlate at higher knowledge levels.

Qualitative findings

Framework Analysis of the 12 KIIs produced five major themes (23 child nodes; inter-coder reliability $\kappa = 0.82$), each

directly integrated with the quantitative findings through the joint display matrix (Table 6). Full thematic findings are presented below in narrative form.

Theme 1: Attitude Formation and the Service Experience

Across 11 of 12 informants, positive attitudes toward GMP were portrayed not as abstract convictions about the programme's worth but as something built up through the accumulated quality of health-service encounters. Mothers who had their growth charts explained, were treated with respect, and found counselling personally relevant developed durable positive attitudes. One regular attendee captured this shift:

“When I come and they put my child on the scale and they explain to me ‘Your child is here, and we need him to reach here’ I feel like I am part of something. But when they just write and don't talk to me, I feel like I am just a number. Why will I come back?” — KII-06, Mother (regular attendee), age 24.

Negative attitudes, by contrast, were traced to specific ‘critical incident’ encounters—long waits, dismissive communication, or the absence of any growth-chart explanation. One non-attending mother described a single encounter that sealed her disengagement:

“The first time I went, I waited from morning to afternoon. My child was crying, I was hungry. When they finally weighed her, they said she was fine and told me to go. Nobody explained anything. I went home and I said ‘what is the use?’ I didn't go back.” — KII-08, Mother (non-attendee), age 27.

Relationships with community health workers were named by 10 of 12 informants as the single most powerful attitudinal catalyst—more influential than facility encounters, because CHWs engage mothers in familiar settings using culturally grounded communication. The CHW supervisor stated the programme-level implication plainly: ‘The CHW is the face of health in this village. The programme lives or dies with the CHW.’

Theme 2: Knowledge, Information, and Its Limits

Mothers who attended irregularly nonetheless showed



Table 6: Convergent Mixed-Methods Joint Display Matrix: Quantitative Findings and Qualitative Mechanisms, Sulima Chiefdom, 2026

Quantitative finding	KII theme & nodes	Qualitative mechanism	Convergence	Integration inference
Attitude aOR = 3.72; knowledge fully attenuated (aOR = 1.23, $p = 0.807$)	Theme 1: Attitude formation through service experience (Nodes 1.1–1.3)	Attitude is not an intrinsic belief but is actively built through quality service encounters and CHW relationships. A single negative encounter can crystallise a lasting negative attitude that information cannot reverse.	CONFIRMS ✓	Service quality and CHW capacity must be targeted, not merely knowledge content. Health education without quality service improvement is insufficient.
IYCF counselling aOR=4.20 (independent of all other predictors)	Theme 3: IYCF as motivational mechanism (Nodes 3.1–3.4)	IYCF counselling transforms GMP from passive compliance to purposive behaviour-monitoring. CHW home visits prime mothers before sessions. ANC contact creates postnatal GMP orientation.	CONFIRMS ✓	IYCF integration into every GMP contact is the highest-yield programme investment.
Distance aOR = 0.92/km; unmasked only after adjustment	Theme 4: Geographic access as embodied experience (Nodes 4.1–4.4)	Distance is experienced through terrain, seasonal flooding, physical burden and transport cost, not kilometres. Rainy-season community cutoffs create unmeasured coverage gaps.	EXPANDS ✓	8%/km estimate is conservative. Community-based satellite GMP posts are the unanimous structural solution.
MSG membership aOR = 1.87; most precisely estimated predictor	Theme 5: Social capital and MSG (Nodes 5.1–5.4)	MSG creates attendance accountability norms, diffuses IYCF knowledge laterally, and provides practical support for isolated mothers. Grandmothers are informal gatekeepers who amplify or impede MSG effectiveness.	CONFIRMS ✓	MSG infrastructure is a structural health-system component, not supplementary. Formalising GM–MSG–CHW linkages creates an integrated community health architecture.
Single marital status aOR = 0.57 (negative predictor)	Theme 5, Node 5.3: Single motherhood and social isolation	Single mothers face practical constraints (no partner for child supervision) and social exclusion from MSG networks that provide the accountability and support sustaining regular attendance.	CONFIRMS ✓	Single mothers require targeted outreach: MSG inclusion, CHW–buddy pairing, and childcare support during GMP sessions.

Note: Convergence categories: CONFIRMS = quantitative and qualitative strands reach the same conclusion; EXPANDS = qualitative strand adds dimensions not captured in the quantitative data. No disconfirmatory findings were identified across strands, strengthening overall interpretive credibility.

consistent awareness of GMP and could explain its purpose. The gap between knowing and doing was attributed to competing livelihood demands, deferred male decision-making authority, and deficits of trust. The Chiefdom Nutrition Officer framed it succinctly: ‘We do many health talks. The mothers know what we are saying. But knowledge alone does not move people.’ This account mirrors and helps explain the quantitative mediation finding—that knowledge and attendance co-occur because both arise from the same proximal driver, namely quality service encounters and social-network reinforcement, rather than knowledge directly producing attendance. Distrust of growth charts, present in 6 transcripts, was directly tied to the finding that only 55.4% of attendees received a growth-chart explanation.

Theme 3: IYCF Counselling as a Motivational Mechanism

The most frequently coded node (41 references, 11 sources) captured a transformation in mothers’ relationship with GMP once IYCF counselling was received: a move from passive compliance to purposeful, active monitoring. One mother with six GMP visits over the previous six months described it directly:

“Before I received the IYCF teaching from the CHW, I would go to weighing and come home not knowing what to do differently. After the teaching, I understood: this weight is low because of this I need to add groundnut to the porridge. Now when I go to weighing, I have questions. I am checking: is what I’m doing working?”

— KII-12, Mother (regular attendee, 6 visits), age 29

CHW home visits ahead of GMP sessions were described as ‘pre-session priming’ that generated anticipatory counselling and social accountability. Antenatal IYCF contact was

identified by 8 of 12 informants as the origin of postnatal GMP orientation, lending weight to the case for strengthening ANC-integrated IYCF counselling as a gateway strategy.

Theme 4: Geographic Access, Mobility, and Structural Barriers

Distance to the PHU was experienced not as abstract kilometres but as a multi-dimensional structural burden—terrain, seasonal flooding, the difficulty of transporting a child, and the opportunity cost of travel. One CHW in Turaydansaia (rural, over 10 km to the nearest PHU) described the unmeasured coverage gap created by seasonal flooding: ‘During the rains, some communities are completely cut off. We cannot reach them. The GMP statistics look better than they are because we cannot count the people we never reach.’ This qualitative evidence suggests that the quantitative estimate of 8% per km is conservative; seasonal and terrain effects create coverage gaps invisible to cross-sectional surveys run in the dry season. Across all informant categories, community-based satellite GMP posts staffed by trained CHWs were identified as the structural solution.

Theme 5: Social Capital, Mothers and Grandmothers Support Groups, and Peer Influence

Membership of MSGs and grandmother groups was described as generating attendance accountability through the social visibility of non-attendance, the lateral spread of IYCF counselling content across the peer network, and practical support for isolated mothers. The MSG leader described peer accountability: ‘When a member misses the GMP session, we notice. We will go to her house and ask. It means you feel accountable to the group. You cannot just say I forgot.’ This peer-accountability mechanism—operating



through a norm-based pathway distinct from attitude and perceived benefit—explains the MSG predictor’s independent effect in the multivariable model. Traditional birth attendants were positioned as complementary partners in GMP referral; the Grand Mothers Leader (KII-11) said: ‘I always tell the mothers: go to the weighing. It is not against our tradition. It is how you know your child is growing.’

Discussion

Principal findings and original contributions

This convergent parallel mixed-methods study contributes four original findings to the GMP and child nutrition literature in low-resource settings. First, applying multivariable linear regression with adjustment for established confounders, it shows that regular GMP attendance is independently associated with a 0.365 SD higher HAZ and a 0.343 SD higher WAZ—differences of a magnitude comparable to the observed gap in stunting prevalence between regular and irregular attendees (35.7% versus 19.0%). Second, it quantifies a striking 36 percentage-point gap between ever-attendance and regular attendance in Sulima Chiefdom, demonstrating that coverage metrics on their own can be misleading proxies for programme effectiveness. Third, a formal mediation analysis indicates that attitude accounts for an estimated 25.3% of the association between knowledge and GMP attendance, providing the first quantified mechanistic evidence consistent with a knowledge–attitude–behaviour pathway in this context. Fourth, the convergent qualitative strand supplies the first mechanistic explanation, grounded in community voices, for why the quantitative predictors behave as they do—evidence that neither strand could have generated alone.

The coverage–quality paradox

That 77.8% of mothers had ever attended GMP while only 41.8% attended regularly calls into question the routine use of ever-attendance as a programme performance indicator. Comparable coverage–quality paradoxes have been documented in Ghana, where high nominal GMP coverage sat alongside poor weight-monitoring quality and limited counselling [23], and in Ethiopia, where predictors of GMP utilisation quality diverged systematically from predictors of ever-attendance [11]. In the present study, only 55.4% of attendees received a growth-chart explanation and only 64.3% received nutrition counselling—service-quality failures that constrain GMP’s behaviour-change potential even among those who physically turn up. These results directly support WHO/UNICEF calls to move beyond coverage monitoring toward quality measurement [5]. Sierra Leone’s DHIS2 reporting framework should adopt a regular-attendance rate and a service-quality index as primary programme metrics.

Attitude, not knowledge, as the proximal determinant: a paradigm shift

The attenuation of maternal knowledge from $cOR = 4.72$

to $aOR = 1.23$ ($p = 0.807$) after adjustment— while positive attitude ($aOR = 3.72$) and perceived benefit ($aOR = 1.79$) remained independently significant—carries far-reaching programmatic implications that align with the Health Belief Model [9]. The finding agrees with systematic-review evidence from sub-Saharan Africa showing that knowledge-based GMP interventions delivered in isolation are insufficient to sustain attendance [10], and with the growing recognition that perceived benefit— rather than information content—is the proximal driver of preventive health-seeking behaviour in LMICs [24].

The mediation analysis offers an indicative quantification of this relationship: attitude is estimated to carry 25.3% of the knowledge–attendance association, and the knowledge–attitude interaction reveals a ceiling effect ($B = -0.122, p = 0.015$) whereby attitude becomes the dominant correlate at higher knowledge levels. The qualitative strand explains the underlying mechanism: attitude is not a fixed cognitive predisposition but is actively constructed through accumulated service-quality encounters, and a single sharply negative experience—what the qualitative data term a ‘critical incident’—can crystallise a lasting negative attitude that health education cannot afterward reverse. This implies that health-education talks at GMP sessions, while effective for discrete behaviours such as handwashing and immunisation uptake, are by themselves inadequate to sustain regular attendance. What appears to sustain attendance is a positive experiential attitude built through high-quality, respectful, and purposive service encounters delivered by CHWs who are trained and supervised in respectful counselling, with role-modelling by CHW Supervisors and facility health workers.

IYCF integration and social capital as structural amplifiers

That IYCF counselling through any channel quadrupled the odds of regular GMP attendance ($aOR = 4.20$, 95% CI: 1.40–12.63, $p = 0.010$), independent of knowledge, attitude, perceived benefit, and social capital, suggests that GMP and IYCF form a mutually reinforcing service ecosystem. The qualitative strand accounts for the mechanism through the notion of ‘purposiveness’: IYCF counselling converts GMP from passive compliance—mothers attending because they are expected to—into active nutritional monitoring, in which mothers attend because they hold specific feeding questions and can track whether their practices are working. This is consistent with evidence from integrated nutrition programmes worldwide showing that counselling quality—not coverage alone—is the critical lever for child-growth improvement [25]. The finding supports WHO/UNICEF Essential Nutrition Actions policy, which calls for integrated IYCF and growth-monitoring delivery in place of parallel programming [5].

Mother support group membership was the most precisely



estimated independent predictor (aOR = 1.87, 95% CI: 1.30–2.68), working through a norm-based pathway separate from individual attitude and perceived benefit. The qualitative strand reveals three specific mechanisms: MSGs generate peer accountability for attendance (the social visibility of non-attendance), spread IYCF counselling content laterally across the network to members who did not attend GMP themselves, and offer practical and emotional support to isolated mothers. This is consistent with social network theory applied to health-seeking behaviour in analogous sub-Saharan African community health contexts [26], and with evidence that health-related behaviours diffuse through social ties [27], positioning MSGs not as optional programme add-ons but as structural community health-system components that amplify the impact of every other intervention in the ecosystem.

Geographic access as a structural determinant

Distance to the PHC emerged as a significant structural determinant of regular GMP attendance in the adjusted model (aOR = 0.92 per km, $p = 0.026$), despite failing to reach significance in crude analysis ($p = 0.065$). The confounding structure is instructive: village residence is correlated with both greater distance and lower attendance, so that once village residence and other correlated variables were controlled, the distance effect was unmasked. The 8% reduction in odds per kilometre implies that, for a community 10 km from the PHU, GMP attendance odds are roughly 44% lower than for a community at the facility boundary—a substantial structural barrier that health education or attitude change cannot overcome without matching investment in outreach services.

The qualitative strand expands this quantitative finding in an important way: the 8%/km estimate is likely conservative, because seasonal flooding renders some communities inaccessible for up to three to four months each year—a structural barrier largely invisible to cross-sectional data collected between January and March. The Chiefdom Nutrition Officer's account of unmeasured rainy-season coverage gaps is a critical qualitative contribution that should inform both programme design and research methodology in seasonal-flooding-affected contexts. The unanimous cross-informant recommendation for community-based satellite GMP posts aligns with the quantitative evidence and constitutes the integrated evidence base for this study's primary structural recommendation.

Nutritional status in the context of a declared emergency

The GAM prevalence of 18.3% in this study exceeds the WHO emergency threshold of 15%, placing Sulima Chiefdom in a nutrition emergency that warrants immediate humanitarian and developmental response. The stunting prevalence of 28.7% indicates that chronic undernutrition is entrenched; the age trajectory, rising from roughly 15.8% at 0–5 months to 36.5% at 36–47 months, is consistent with the

globally documented complementary-feeding crisis window described by Victora, et al. and de Onis, et al. [7,28], in which the 6–24-month period is the most critical for preventive intervention [29]. Such early growth faltering carries lifelong implications, given that childhood height deficits track into adolescence and adulthood across populations [30]. The constellation of risk factors observed here—low maternal education, food insecurity, suboptimal exclusive breastfeeding, and recent morbidity—mirrors determinants of under-five undernutrition reported elsewhere in the region [31,32]. A SAM prevalence of 1.0% represents about six children in every 617, each facing a case fatality rate of 20–30% without access to therapeutic feeding—underscoring the urgent referral imperative of a functional GMP in this setting [33].

The 0.493 SD HAZ difference between regular and irregular GMP attendees corresponds, in cross-sectional terms, to a difference in the proportion below -2 SD from 35.7% to 19.0%—a 16.7 percentage-point difference. This contrast is observational rather than a counterfactual forecast: it assumes a constant effect size and no residual selection, neither of which can be verified in a cross-sectional design, and it should be read against the models' limited explained variance ($R^2 = 0.10$). Interpreted cautiously, it nonetheless illustrates the potential scale of benefit if regular, quality GMP participation could be expanded, and provides an indicative basis for investment and target-setting—including future cost-effectiveness analysis using established health-economic costing approaches [34]—that is currently absent from Sierra Leone's district health planning frameworks. The present evidence should inform the next BPEHS revision cycle [14], with confirmation from longitudinal or quasi-experimental designs.

Limitations

The cross-sectional design precludes causal inference; the observed association between GMP attendance and more favourable z-scores could reflect healthy-user bias, whereby more health-conscious families are both more likely to attend GMP and to have better-nourished children. Reverse causation is also possible, in that caregivers of healthier children may attend more readily. However, four analytical features reduce—though they cannot eliminate—this concern: (1) multivariable linear regression controlled for 11 plausible confounders including household food security, morbidity, feeding practices, and knowledge; (2) a dose-response gradient was observed (Spearman $\rho = 0.170$, $p < 0.001$), consistent with one of the Bradford Hill considerations; (3) the biological plausibility of GMP improving child growth through counselling-driven behaviour change is supported by experimental and quasi-experimental literature from analogous settings; and (4) the qualitative strand provides mechanistic evidence consistent with the proposed direction of effect. These features strengthen plausibility but do not



establish causation, which would require longitudinal or experimental confirmation.

The linear models explained only 10.0% and 8.9% of the variance in HAZ and WAZ respectively, indicating substantial residual variation attributable to factors not measured in this cross-sectional design. Although robust, cluster-aware variance estimation was applied to account for the twostage sampling design, residual intracluster correlation may still influence standard errors; future research should use multilevel (mixed-effects) modelling with village-level random effects and report the design effect explicitly. A second analytic limitation is that the comparison group combined irregular attendees with never-attenders, which may accentuate the contrast with regular attendees; the dose-response analysis partially addresses this, but a three-level exposure (never / irregular / regular) would provide a cleaner specification for future work. Several adjusted odds ratios—notably for IYCF counselling (aOR = 4.20, 95% CI: 1.40–12.63)—have wide confidence intervals, reflecting limited numbers in some predictor categories; results for these variables should be interpreted with corresponding caution, and the mediation estimates are likewise exploratory given the cross-sectional design. The study's lack of programme-quality assessment at the individual GMP session level is a further gap: future research should capture counselling-quality scores to disentangle the effect of attendance frequency from the quality of each contact. Recall bias for self-reported GMP visits is possible, though the use of child health cards as verification partially mitigated this risk. The study is geographically bounded to Sulima Chiefdom; while the socioeconomic profile is broadly representative of rural Falaba District and comparable Northern Province communities, direct generalisation to other districts or countries requires caution.

Conclusion and recommendations

To the authors' knowledge, this study provides the first community-level, convergent mixed methods evidence from Sulima Chiefdom, Sierra Leone, showing that regular GMP attendance is independently associated with improved child linear growth and ponderal status, with a difference in stunting prevalence of more than 16 percentage points between regular and irregular attendees and a near-halving of wasting prevalence. The study community is in a nutrition emergency, with

GAM exceeding the WHO emergency threshold at 18.3%, and the 36 percentage-point gap between ever-attendance and regular attendance represents an urgent and addressable programmatic failure.

Critically, the key modifiable drivers of regular attendance are not individual-level knowledge—which is fully attenuated in the adjusted model—but attitudinal, relational, and structural factors: a positive experiential attitude toward GMP (aOR = 3.72), integration with IYCF counselling (aOR = 4.20),

participation in mother support groups (aOR = 1.87), and geographic access. Exploratory mediation analysis indicates that attitude accounts for an estimated 25.3% of the knowledge–attendance association, and qualitative evidence supplies the mechanistic foundation for each quantitative finding. Together, these findings support a programmatic pivot from information-centred health education to quality-centred service delivery, social-capital investment, and structural outreach.

Recommendations for programme and policy

Redefine GMP success metrics: Sierra Leone's DHIS2 framework should adopt the regular attendance rate (≥ 4 sessions/6 months) and a service-quality index (counselling received, growth-chart explanation, weight recorded) as primary programme indicators, replacing ever-attendance. This single reporting change would expose the coverage–quality gap that currently allows poorly performing programmes to appear successful.

Integrate IYCF counselling universally: Given aOR = 4.20, IYCF counselling through community health workers, ANC, and community sessions should be delivered as a standard integrated package—not separated from GMP—across all PHU catchments, consistent with WHO/UNICEF Essential Nutrition Actions guidelines. This must be paired with urgent initial and refresher training for all CHWs on IYCF counselling and on respectful, nonjudgmental contact at every GMP touchpoint (weighing, counselling, referral); without addressing CHW capacity, quality improvement will not materialise.

Invest in mother support groups as health-system infrastructure: MSGs should be formally embedded in the community health worker programme with structured training, facilitation manuals, and district-level monitoring—particularly inclusive of single mothers and recent community migrants, who are most vulnerable to social isolation.

Deploy satellite GMP posts for distant communities: The 8%/km distance effect mandates community-based GMP delivery for populations more than 5 km from the nearest PHC (26.9% of this sample), staffed by trained, supervised CHWs with calibrated, maintained equipment and operating through both dry and rainy seasons. CHWs at satellite and outreach posts should receive structured supportive supervision, as improved access without supervision will not sustain service quality.

Initiate an emergency nutrition response: GAM above 15% triggers the CMAM emergency threshold; Sulima Chiefdom requires immediate scale-up of therapeutic feeding alongside GMP quality improvement, consistent with Sierra Leone's National Nutrition Policy 2021–2025 [14] and national CMAM protocols.



Engage traditional birth attendants and community leaders formally: The qualitative evidence shows that Grand Mothers and community leaders act as informal GMP gatekeepers with substantial community trust. Formalising their role in GMP referral through structured community health worker linkage protocols is a low-cost, high-leverage structural investment.

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Declarations

Data availability: The anonymised dataset supporting the findings of this study is available from the corresponding author upon reasonable request.

Ethical approval: Obtained from the Njala University Institutional Review Board and the Sierra Leone Ethics and Scientific Review Committee.

COREQ compliance: The qualitative strand was reported in accordance with the Consolidated Criteria for Reporting Qualitative Research [22]. A complete 32-item checklist is available as a supplementary file upon request.

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