



Nutrition Education and Cognitive Development in Early Childhood: A Cluster Quasi-Experimental Study in Enugu State, Nigeria

Ebeh Jideofor Jeremiah

Department of Education Foundation and Administration, Federal College of Education, Eha-Amufu, Enugu State, Nigeria

Corresponding author: Ebeh Jideofor Jeremiah, Department of Education Foundation and Administration, Federal College of Education, Eha-Amufu, Enugu State, Nigeria.

How to cite this article

Ebeh, J. J. (2026). Nutrition education and cognitive development in early childhood: A cluster quasi-experimental study in Enugu State, Nigeria. *African Health Frontier*, 1(1), 1–8.

ABSTRACT

Background. Stunting remains common among preschoolers in Enugu State and is a recognised marker of risk for poor early learning. Nutrition education for caregivers and teachers is a scalable complement to school feeding, yet few Enugu studies have tested whether such education changes early cognitive scores rather than knowledge or growth alone.

Objective. This cluster quasi-experiment assigned 24 public early childhood care and education centres in urban and rural Enugu local government areas to a 12-week bilingual (English, Igbo) nutrition-education package or to usual care.

Methods. Twelve centres (174 children aged 36–59 months) received the package covering local complementary foods, meal frequency, hygiene and classroom snack practice. Twelve centres (174 children) continued usual care. Outcomes were caregiver knowledge and recommended practices, child dietary diversity, WHO anthropometric z-scores and the IDELA composite. Linear mixed models used centre as a random effect.

Results. The intervention arm had higher posttest knowledge, dietary diversity and IDELA composite scores after pretest and socioeconomic covariates. Indirect effects through knowledge and dietary diversity accounted for 51.4% of the cognitive gain. The cognitive advantage was larger among children who were stunted at baseline and was present in both urban and rural centres.

Conclusions. Nutrition education can improve early cognitive scores in Enugu ECCE settings when it is bilingual, food-based and linked to classroom practice.

Keywords: nutrition education, early childhood, cognitive development, stunting, dietary diversity, IDELA, Enugu, Nigeria



1. Introduction

The first years of life are a sensitive period for brain growth. Adequate energy, protein, iron, zinc, iodine and essential fatty acids support synapse formation and later learning, while chronic undernutrition, especially stunting, marks children who are less likely to reach their developmental potential (Black et al., 2017; Prado & Dewey, 2014; Victora et al., 2008). Globally, about 250 million children under five in low- and middle-income countries are estimated to be at risk because of stunting or extreme poverty (Black et al., 2017). Nigeria contributes a large share of that burden: national estimates still place stunting near two in five children under five, and stunted children perform worse on early literacy and numeracy tasks (National Population Commission & ICF, 2019).

Enugu State is not exempt. Recent work in early child-care centres found that 37.5% of preschoolers were stunted and 29.6% underweight. Earlier Enugu samples linked poorer anthropometry to weaker cognitive performance, particularly in rural communities (Ejekwu et al., 2012). These figures sit beside an active policy environment: the Enugu State Multi-Sectoral Plan of Action for Food and Nutrition, Child Nutrition Fund commodities, deworming campaigns and school-feeding allocations attached to Smart Green Schools (Enugu State Ministry of Budget and Planning, 2020).

Feeding programmes address access to food. They do not automatically teach caregivers how to assemble a diverse plate from local staples or how teachers should use snack time as a learning moment. Nutrition education is the missing instructional layer in the Nurturing Care Framework, which treats adequate nutrition and opportunities for early learning as joint components of development (World Health Organization, 2018). Evidence from complementary-food trials in Enugu shows that locally formulated mixes can improve anthropometry and micronutrient status in younger children (Nnam et al., 2025). What remains thin is experimental evidence that a caregiver-and-teacher education package, without a parallel food transfer, can move preschool cognitive scores.

This study tested that claim in public ECCE centres. The primary developmental endpoint was the IDELA composite. Secondary endpoints were caregiver knowledge and practices, child dietary diversity and anthropometric z-scores. Four questions guided the analysis: whether the package would raise caregiver knowledge and recommended feeding practices; whether child dietary diversity and IDELA scores would improve after covariates; whether knowledge and dietary diversity would mediate the cognitive effect; and whether gains would be larger among children who were stunted at baseline, with rural centres sharing the benefit. Findings among older primary pupils in Enugu-East are more mixed once socioeconomic status is controlled, which is a reminder that nutrition–cognition links are strongest when measured closer to the early-childhood window. Education is the cheapest way to add adult mealtime behaviour if the curriculum is local and short.



2. Literature and conceptual framework

Reviews of maternal and child undernutrition show that growth faltering in the first 1,000 days is associated with lower school attainment and adult income (Victora et al., 2008). Early-onset persistent stunting predicts lower cognitive scores at age five even after home stimulation and socioeconomic status are considered (Alam et al., 2020). Iron and other micronutrients support attention and learning; food insecurity and poor complementary feeding reduce the nutrients available for that work (Prado & Dewey, 2014). In Enugu, Ejekwu et al. (2012) reported high rates of below-average performance on Raven's matrices and a significant association between stunting and cognition among rural children.

Nutrition education changes knowledge and feeding behaviour when messages are specific, culturally familiar and repeated (Contento, 2008). Education is not a substitute for food access. It can raise dietary diversity when households have some food to reallocate, and it can make school feeding more developmentally useful if teachers treat meals as language and routine opportunities (World Health Organization, 2018). School feeding evaluations in Nigeria show gains in enrolment and, in some states, in meal quality, but they rarely report a direct early-childhood cognitive endpoint.

The Nurturing Care Framework organises early development around good health, adequate nutrition, responsive caregiving, early learning and safety (World Health Organization, 2018). This study treated nutrition education as a joint nutrition-and-learning intervention: sessions taught food choice and also modelled how adults talk with children during meals. Stunting was specified as a moderator because children who start further from the growth standard have more developmental ground to gain if diet and stimulation improve together (Black et al., 2017; Grantham-McGregor et al., 2007). Positive-deviance and rural-mother programmes in Enugu communities such as Eha-Amufu have documented weak exclusive-breastfeeding concepts and food-selection beliefs that education can target. Integrating nutrition into early-childhood teacher preparation is consistent with Nigeria's ECCE food-and-nutrition curriculum for ages 3 to 5. School feeding evaluations in Nigeria show gains in enrolment and, in some states, in meal quality, but they rarely report a direct early-childhood cognitive endpoint. That gap matters in Enugu, where feeding budgets are rising while ECCE classrooms still need an adult who can turn a meal into language, counting and a clean-hand routine.

3. Methods

A cluster quasi-experimental pretest–posttest control-group design was used. Twenty-four public ECCE centres in Enugu North, Enugu East, Nsukka, Udi, Nkanu West and Igbo-Etiti were assigned by intact cluster, balanced on urban or rural location and enrolment size, to intervention or usual care. Individual randomisation inside centres was rejected because snack practice and teacher talk would have contaminated control children. Data were collected at baseline (Week 0), at the end of the 12-week package (Week 12) and at a 4-week follow-up for the cognitive composite only.

Eligible children were 36–59 months old, enrolled for at least one month, and living with a primary caregiver who could attend sessions. Of 392 screened children, 348 (174 per arm) completed baseline and Week-12 assessments. Mean age was 47.2 months (SD = 6.8); 51.1% were girls. One hundred twenty-four children (35.6%) were stunted (HAZ < -2). Twenty-four teachers and 28 caregivers completed interviews.

Nri-Amamihe (Food-Knowledge) comprised 12 weekly 70-minute group sessions for caregivers, a parallel four-session teacher module, and picture cards in English and Igbo. Topics were continued breastfeeding where relevant, meal frequency, four-star local plates (staple, legume or animal source, vegetable, fruit), iron-rich and vitamin A-rich foods, hygiene and safe water, reducing sugar-sweetened snacks, and using mealtime for naming, counting and conversation. Demonstrations used beans, crayfish, garden egg, ugu, banana, egg and maize. Teachers practised a 10-minute snack-time talk routine. No cash or food basket was provided. Mean session fidelity was 91%.

Caregiver nutrition knowledge was a 40-item test written with two dietitians and piloted in a non-study centre ($\alpha = .84$ pretest, .86 posttest). Recommended practices were a 16-item frequency scale ($\alpha = .81$). Child dietary diversity used an adapted WHO eight-group indicator for the previous day, scored 0 to 8. Anthropometry followed WHO protocols; HAZ, WAZ and WHZ were computed against WHO (2006) standards. Cognitive development was the IDELA total score expressed as percent correct across emergent literacy and numeracy, motor, socio-emotional and executive-function items (Pisani et al., 2018). Assessors were trained to inter-rater agreement of $\kappa \geq .80$ on a 20-child practice set. A brief six-item home-stimulation index and an asset-based socioeconomic score were covariates.

Analyses used linear mixed models with arm, pretest, child age, sex, socioeconomic score, home stimulation and a random intercept for centre. Binary stunting used mixed-effects logistic models. Mediation used cluster-robust path estimates with 5,000 bootstrap draws. Moderation models added arm $\times$ baseline stunting and arm $\times$ urban or rural terms. Interviews with 28 caregivers and teachers were coded with reflexive thematic analysis. Sessions were facilitated by two trained dietitians and two ECCE supervisors. Caregivers who missed a week received a 20-minute make-up visit. Fidelity was checked with a 12-item observer checklist on a random third of sessions.

4. Results

Arms did not differ at baseline on age, sex, urban residence, socioeconomic score, stunting, knowledge, dietary diversity or IDELA (all $p > .25$). Rural centres had higher stunting (42.4%) than urban centres (28.9%), $\chi^2(1) = 6.91$, $p = .009$.

Table 1. Sample characteristics at baseline

Characteristic	Intervention	Control	p
Child age in months, M (SD)	47.4 (6.7)	47.0 (6.9)	.59
Girls, n (%)	90 (51.7)	88 (50.6)	.83

Urban centre, n (%)	88 (50.6)	86 (49.4)	.83
Maternal secondary or higher, n (%)	97 (55.7)	101 (58.0)	.67
Stunted (HAZ < -2), n (%)	63 (36.2)	61 (35.1)	.82
Underweight, n (%)	50 (28.7)	48 (27.6)	.81
Wasted, n (%)	21 (12.1)	19 (10.9)	.74

Note. n = 174 per arm. HAZ = height-for-age z-score.

Table 2. Baseline nutritional and developmental scores

Measure	Intervention M (SD)	Control M (SD)	p
Knowledge (0–40)	21.6 (5.4)	21.9 (5.1)	.60
Recommended practices (1–5)	2.71 (0.62)	2.74 (0.59)	.65
Dietary diversity (0–8)	3.28 (1.19)	3.31 (1.14)	.81
HAZ	–1.61 (1.08)	–1.57 (1.11)	.73
IDELA composite %	46.8 (11.2)	47.2 (10.9)	.74

Note. IDELA = International Development and Early Learning Assessment.

Table 3. Week-12 outcomes by study arm

Outcome	Int. M (SD)	Ctrl M (SD)	Adj. B	p	d
Knowledge	32.1 (4.6)	22.6 (5.3)	9.42	< .001	1.82
Practices	3.68 (0.51)	2.81 (0.58)	0.86	< .001	1.51
Dietary diversity	4.54 (1.08)	3.38 (1.16)	1.14	< .001	0.98
IDELA composite %	58.2 (10.4)	50.4 (11.1)	7.62	< .001	0.71
HAZ	–1.48 (1.04)	–1.55 (1.09)	0.11	.048	0.15

Note. Adjusted B from mixed models controlling for pretest, age, sex, SES, home stimulation and urban location. d is the unadjusted posttest effect size.

Table 4. Mediation of the intervention effect on the IDELA composite

Path	B	SE	95% CI	p
Intervention → knowledge	9.42	0.61	[8.22, 10.62]	< .001
Intervention → diet diversity	1.14	0.14	[0.86, 1.42]	< .001
Knowledge → IDELA	0.23	0.06	[0.11, 0.35]	< .001
Diet diversity → IDELA	1.53	0.41	[0.72, 2.34]	< .001
Indirect via knowledge	2.18	0.53	[1.21, 3.29]	
Indirect via diet diversity	1.74	0.46	[0.88, 2.71]	
Direct effect	3.70	1.18	[1.38, 6.02]	.002

Note. Cluster-robust bootstrap intervals, 5,000 draws. Combined indirect paths accounted for 51.4% of the total effect of 7.62 points.

Table 5. Week-12 IDELA composite by arm, baseline stunting and location

Stratum	Intervention M (SD)	Control M (SD)	Difference
Stunted at baseline	54.8 (9.7)	45.1 (10.4)	9.7
Not stunted	60.1 (10.3)	53.3 (10.6)	6.8
Urban centres	60.4 (10.1)	52.6 (10.8)	7.8
Rural centres	55.9 (10.4)	48.2 (11.0)	7.7

Note. Arm × baseline-stunting interaction B = 3.41, SE = 1.62, p = .036. Arm × urban or rural interaction B = –1.08, p = .41.

Follow-up at Week 16 showed that the IDELA advantage remained, B = 6.41, SE = 1.21, p < .001. Emergent numeracy and executive-function subdomains contributed most of the composite difference. Interviews highlighted affordable local foods (beans, crayfish, ugu and egg), Igbo session language, teacher snack routines, cost and seasonality of animal-source foods, and the need to align education with existing feeding programmes.

Table 6. Qualitative themes from caregivers and teachers

Theme	n	Summary	
Local-food substitution	22	Beans, crayfish, ugu and egg were cited as realistic upgrades.	
Igbo session language	18	Vernacular examples reduced shame about not knowing English nutrition terms.	
Teacher snack routine	14	Naming and counting during snacks was new for most teachers.	
Cost and seasonality	21	Animal-source foods dropped when prices rose or harvest ended.	
Align with feeding programmes	16	Education without a matching meal was harder in poorer households.	

Note. n is the number of unique informants contributing to the theme. Twenty-eight interviews were analysed.

5. Discussion

A 12-week bilingual nutrition-education package improved caregiver knowledge, child dietary diversity and preschool cognitive scores. The cognitive effect was medium to large ($d = 0.71$), survived a short follow-up, and was partly explained by knowledge and diet. Children who began the study stunted gained more on IDELA than better-grown peers. Rural centres were not left behind. Growth z-scores barely moved, which is expected from an education-only package of this length and consistent with the distinction between feeding trials that change body size (Nnam et al., 2025) and education trials that change practice and learning opportunities.

These results sit in the Nurturing Care Framework (World Health Organization, 2018). Nutrition and early learning were delivered through the same adults. The residual direct path in the mediation model likely captures that dual channel: adults who learn about food also talk more during meals. That interpretation matches global evidence that stimulation and nutrition together protect development better than either alone (Grantham-McGregor et al., 2007; Black et al., 2017).

The modest HAZ change cautions against advertising nutrition education as a stunting-reduction programme. Twelve weeks is short for linear growth. Dietary diversity and cognition are the honest near-term endpoints. Cost and seasonality themes equally caution against treating education as sufficient in the lean season. Pairing the package with existing feeding menus and agricultural extension, already named in the state multi-sectoral nutrition plan, is the scalable next step (Enugu State Ministry of Budget and Planning, 2020).

Interviews developed five themes. Caregivers described switching from afternoon plates of swallow and soup only to adding beans, egg or green leaves after sessions. Teachers said the snack-time script gave them something concrete to do. Cost and seasonal scarcity limited animal-source foods. Several rural caregivers said education helped only on weeks when the market or farm yielded something to cook. Staff asked that future packages be timed with existing Maternal, Newborn and Child Health weeks and school-feeding menus so

messages and meals match. These themes caution against treating education as sufficient in the lean season and support pairing the module with commodities already procured by the state.

Cluster assignment was not fully randomised, so unmeasured centre differences remain possible. Assessors could not be blinded to every centre's status. Dietary diversity was a single previous-day recall. IDELA is robust in low-resource settings but is not an intelligence test (Pisani et al., 2018). Micronutrient biomarkers were not collected. The sample excludes children outside ECCE, who may be at higher nutritional risk. Four-week follow-up cannot speak to school-entry achievement. Wasting and underweight prevalence did not differ by arm, which again shows that an education-only package of this length should not be sold as a growth programme.

For households in the lean season, education should be paired with the Child Nutrition Fund commodities already procured by the state and with agricultural extension on household gardens, which the multi-sectoral nutrition plan already names as a result area. A standalone lecture will not offset an empty market. A coordinated message across health week, ECCE and school feeding can. Rural centres should not be last in training queues. Monitoring should include dietary diversity and a brief early-learning score, not weight alone.

6. Conclusion and recommendations

Nutrition education for caregivers and ECCE teachers improved early cognitive scores in Enugu preschoolers, with larger gains among children who were stunted at baseline and with comparable benefit in rural and urban centres. Knowledge and dietary diversity carried about half of the effect. Education will not replace food transfers, but it is a feasible way to convert Enugu's nutrition and school-feeding investments into early learning.

ECCE departments and the State Committee on Food and Nutrition should adopt a short, bilingual caregiver-and-teacher module rather than one-off nutrition talks. Teacher colleges can fold the snack-time routine into ECCE practicum. Smart Green School feeding menus should be printed beside the four-star plate. Rural centres need the package as much as urban centres. Monitoring should include dietary diversity and a brief early-learning score, not weight alone. In the lean season, education should be paired with Child Nutrition Fund commodities and household gardens.

References

- Alam, M. A., Richard, S. A., Fahim, S. M., Mahfuz, M., Nahar, B., Das, S., ... Ahmed, T. (2020). Impact of early-onset persistent stunting on cognitive development at 5 years of age: Results from a multi-country cohort study. *PLOS ONE*, 15(1), e0227839.
- Black, M. M., Walker, S. P., Fernald, L. C. H., Andersen, C. T., DiGirolamo, A. M., Lu, C., McCoy, D. C., Fink, G., Shawar, Y. R., Shiffman, J., Devercelli, A. E., Wodon, Q. T., Vargas-Barón, E., & Grantham-McGregor, S. (2017). Early childhood development coming of age: Science through the life course. *The Lancet*, 389(10064), 77–90.
- Contento, I. R. (2008). Nutrition education: Linking research, theory, and practice. *Asia Pacific Journal of Clinical Nutrition*, 17(Suppl. 1), 176–179.



-
- Ejekwu, A. D., Ene-Obong, H. N., & Oguizu, O. J. (2012). Nutritional status and cognitive performance among children aged 5–12 years from urban and rural areas of Enugu State, Nigeria. *African Journal for the Psychological Study of Social Issues*, 15(2), 481–496.
- Enugu State Ministry of Budget and Planning. (2020). Enugu State multi-sectoral plan of action for food and nutrition 2021–2025.
- Grantham-McGregor, S., Cheung, Y. B., Cueto, S., Glewwe, P., Richter, L., & Strupp, B. (2007). Developmental potential in the first 5 years for children in developing countries. *The Lancet*, 369(9555), 60–70.
- National Population Commission & ICF. (2019). Nigeria demographic and health survey 2018. NPC and ICF.
- Nnam, N. M., Ani, P. N., & Chukwuemeka, N. E. (2025). Effect of locally formulated complementary foods on anthropometric parameters and micronutrient status in children (6–23 months) in Enugu State, Nigeria. *Preventive Nutrition and Food Science*, 30(2), 110–119.
- Pisani, L., Borisova, I., & Dowd, A. J. (2018). Developing and validating the International Development and Early Learning Assessment (IDELA). *International Journal of Educational Research*, 91, 1–15.
- Prado, E. L., & Dewey, K. G. (2014). Nutrition and brain development in early life. *Nutrition Reviews*, 72(4), 267–284.
- Victora, C. G., Adair, L., Fall, C., Hallal, P. C., Martorell, R., Richter, L., & Sachdev, H. S. (2008). Maternal and child undernutrition: Consequences for adult health and human capital. *The Lancet*, 371(9609), 340–357.
- World Health Organization. (2018). Nurturing care for early childhood development. WHO.