Adaptation of a mental development assessment tool for the evaluation of the long-term effect of a successful nutrition intervention in Ghana

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Abstract

This study adapted a cognitive assessment tool to be used in evaluating nutrition interventions in developing countries and assessed its reliability and validity in Ghana. The tool was used to evaluate the long-term effect of the Enhancing Child Nutrition through Animal Source Food Management (ENAM) project. The former ENAM participants' children were contacted (now 13 to 15 years old). The items in the Wechsler Abbreviated Scale of Intelligence-II were adapted, pretested, refined, and pretested again. Cross-sectional data collection was conducted with former ENAM participants (60 interventions and 51 comparison families) in one of ENAM's three sites (the Guinea Savanna zone). Data on participants' socio-economic status and food insecurity were collected, along with their children's intellectual functioning, dietary intake, school attainment, anthropometry, and symptoms of depression. Alpha coefficient of the verbal subscale improved between the first and second pretest (from .34 to .80). After controlling for age, the intelligence scores of the children were associated with their grade ($r = .35$, $p = .001$) and academic performance ($r = .26$ to $.33$, $p < .05$). The verbal scale was associated with their anthropometry ($r = .24$ to $.27$, $p < .05$). The intervention children still recorded a better dietary diversity score than controls (6.8 vs 5.8, $p = .0001$); however, significance was lost after adjusting for confounders. There were no significant group differences in growth or intellectual functioning. The adapted Wechsler Abbreviated Scale of Intelligence-II tool performed well in evaluating adolescent intellectual functioning in rural Ghana, and there were no long-term effects of ENAM intervention on child growth and development.

KEYWORDS

child development, intellectual assessment, intervention evaluation

1 | INTRODUCTION

Nourishment of children during their first years of life can have a profound effect on children's health status and their ability to learn, communicate, think analytically, socialize effectively, and adapt to new environments and people (World Bank, 2016). The scope of this

problem was recently documented in a Lancet series on early childhood development. It was estimated that more than 250 million or 43% of children under 5 years of age in developing countries are not fulfilling their developmental potential (Britto et al., 2017). Reanalysis of three studies from the Philippines, Jamaica, and Brazil show that early cognitive development predicted later school outcomes, and that stunting,

an indicator of chronic malnutrition in the early years, resulted in poor school attainment and economic productivity in adulthood in some longitudinal studies (Grantham-McGregor et al., 2007; Hoddinott, Maluccio, Behrman, Flores, & Martorell, 2008). Consequently, a number of nutrition interventions have been evaluated in terms of mental development outcomes in addition to nutritional status.

Nutrition interventions were key to some of the successes in meeting the Millennium Development Goals (Jones et al., 2003), and nutrition continues to be one of the driving forces to achieving the new Sustainable Development Goals, especially Goals 2 and 3 (Haddad et al., 2015). However, there have been only a few studies (Chang, Walker, Grantham-McGregor, & Powell, 2002; Grantham-McGregor, Walker, Chang, & Powell, 1997; Hoddinott et al., 2008; Yousafzai et al., 2016) that have been published following-up the beneficiaries of nutrition interventions to see the long-term impact on children's development and their families' welfare. One of the longest follow-up of a nutrition supplementation trial before age 3 years showed beneficial effects on schooling, reading, and intelligence tests during adulthood (Maluccio et al., 2006). However, variation and complexity of child development assessment tools have made quantifying children's development very challenging in low- and middle-income countries. A variety of tools have been developed worldwide and modified for use in developing countries (Kramer et al., 2008; Singla, Shafique, Zlotkin, & Aboud, 2014). General intellectual functioning typically refers to global or overall level of intelligence and considers mainly cognitive and language abilities including reasoning. Although there are many cognitive and language components that contribute to overall intellectual functioning, standardized tests assess how these components are used to solve problems and express one's thoughts. Thus, general measures are more likely to be related to school and work performance than is a specific test of memory or attention. There is a need for follow-up studies on nutrition interventions to properly quantify their long-term effect on the beneficiaries.

The Enhancing Child Nutrition through Animal Source Food Management (ENAM) project is a successful example of a program integrating several sectors. It involved 16 months of microcredit loans and weekly nutrition and entrepreneurial education for 179 women with children 2–5 years old. There were also 142 nonparticipating women and their children from the same community and 287 women and their children from similar neighbouring villages (comparison group; Colecraft et al., 2012). The project, implemented in 2005 to 2006, was evaluated using a nonrandomized pretest design, with matched groups tested at baseline and end line. The study improved children's nutritional status (Marquis et al., 2014). As an integrated program with a livelihood component, it may be more successful than a solely nutrition intervention in maintaining the early benefits in nutritional status. Our goal was therefore to evaluate the long-term effect of the ENAM project on children's nutritional status, intellectual functioning, school performance, and the household socio-economic status. Intellectual functioning and school performance were not included in the initial project assessments.

An appropriate measure to use both in developed and developing countries for follow-up over the course of many years, including

Key messages

- The adapted WASI II tool is valid and should be used in assessing intellectual functioning of adolescent children in developing countries. The vocabulary subscale of the tool however must be adapted to local language and culture before use. Consultation with a tertiary-level institution studying the local language should be done to ensure each item in the vocabulary subsection maintains its difficulty level. Interventions studies that have succeeded in improving household food insecurity and the nutritional status of preschool children may not have long lasting effect on child mental development and school performance at adolescent stage.

adolescence, is the Wechsler Abbreviated Scale of Intelligence (WASI). This tool is individually administered to assess cognitive and language functioning of individuals between the ages of 6 and 90 years. It provides estimated composite scores for individuals' verbal and nonverbal reasoning abilities. It consists of four subtests, namely, vocabulary, similarities, matrix reasoning, and block design—the first two are verbal and the last two nonverbal (perceptual). The administration of all four subtests is a means of assessing an individual's verbal, nonverbal, and general cognitive functioning in approximately 30 to 45 min (Wechsler, 2011). The WASI is a brief but valid measure of intelligence that has been adapted for use in different settings (Kramer et al., 2008).

The objectives of this study were to adapt a mental development assessment tool to be used with adolescent children in developing countries and to evaluate the long-term effect of the ENAM project on the beneficiaries' children's development. We hypothesized that the adapted WASI tool would be reliable and valid, correlating well with anthropometric indicators and with school performance. The ENAM intervention children were expected to have better physical development and intellectual function than those in the comparison communities.

2 | METHOD

2.1 | Study overview and design

The study was an 11-year follow-up of the ENAM participants in the savanna agroecological zone of Ghana. There were four communities: one rural intervention community (I1) and its comparison community (C1) and one peri-urban intervention community (I2) and its comparison (C2). After translating the WASI-II into the local languages and modifying verbal items, it was pretested in a selected local private school. This was followed by a resurvey of the participants of the ENAM project.

2.2 | Selection and distribution of participants

Mothers and their children who participated in the ENAM study in the intervention and comparison sites, who currently reside in the selected community, were selected for this study. Children who were too mentally handicapped to participate in our tests were excluded from the study.

The list of ENAM participants and their families were obtained from the project investigators who met with women groups and key informants to identify the ENAM project participants. Out of the 142 ENAM participants in the selected zone, 60 interventions and 51 control households ($n = 111$ mothers and $n = 116$ adolescent children; five children with large amounts of missing data were dropped) were retraced and interviewed after their consent was obtained (Figure 1).

2.3 | Ethics

Ethical clearance was obtained from McGill University and from the University of Ghana's Ethics Committee for Basic and Applied Sciences. Support letters were obtained from local government offices (Navrongo district Ministry of Food and Agriculture and Ghana Education Services) and consents of local authorities and opinion leaders in the study communities were obtained during a reconnaissance visit. Signed informed consent to be contacted was obtained from the ENAM participants before they were approached concerning details of the current study. Signed parent informed consent and child assent were then obtained for participation in the current study (during both pretest and survey).

2.4 | Modification and pretesting of the WASI II

Three of the communities (two interventions and one control spoke Kasem language) and the last control community (C2) spoke predominantly Bulin language. The WASI II tool (Wechsler, 2011) was therefore adapted and then translated into the two languages (Kasem and Bulin). Words in the verbal subtests were replaced with local words with similar difficulty levels. The nonverbal block design subtest was adapted by adding more practice items to improve respondents'

familiarity with the materials. Each item was translated into the local language and back-translated into English to ensure that it maintained its intended purpose in both languages. After the tool was modified, four research assistants were trained to administer the tests in a standard way (e.g., clarification of instructions, repetition of the item, and pace). They then practised administering the test among themselves and within the local community for a week.

The tool was then pretested in a private school within the Navrongo town. One of two classes from each grade was randomly selected to participate. A detailed explanation of the project and the pretest was then given to the selected class, and children who were interested in participating were then invited, based on a random selection of males and females to fit the number required from each grade. A total of 50 children from four grade levels (Grades 4 to 7) who wanted to participate were given consent forms to be signed by their parents. The parents of 47 children returned a signed consent letter. Of these 47, 30 children needed for the pretest were selected at random to participate. They gave assent and then were tested on the WASI II; after 1 week, they were retested to obtain test-retest reliability. Information on their socio-demographic status, anthropometry, and depression was also collected.

Looking at the responses of the children in the vocabulary pretest, it became clear that the difficult items had been translated into easy synonyms and were answered by most children. The idea is to have difficult words such as *panacea*, *perfunctory*, and *pavid* that are not commonly spoken but might be understood by older, educated people. Many adolescents were unexpectedly defining the words because the translation of *panacea* was closer to elixir, and the translation of *pavid* was closer to shy. After discussing the issue with a local language professor, we arrived at a solution that substituted idiomatic expressions and proverbs for the difficult words. Understanding the indirect meaning of a sophisticated expression required a higher level of proficiency. Idiomatic expressions and proverbs were therefore selected to match the difficulty of the final 10 vocabulary items. The newly adjusted tool was retested again in the same school. This time, children in Grades 2 to 8 were included. The block design and similarity subscales also had more practice items added to make

NB: Not assigned=Intervention participants were matched against the controls, so control children left without a matching intervention child were listed as not assigned.

FIGURE 1 Selection and participation of Enhancing Child Nutrition through Animal Source Food Management project respondents

instructions and materials more familiar to the children. A total of 30 children were involved in the second pretest. They were retested after a week. Raw scores for each subtest and a composite for verbal and nonverbal and total were calculated.

We derived raw scores and standardized scores for analysis; raw scores were translated into standardized scores provided by WASI-II standardization manual (Wechsler, 2011), which then allow researchers to derive a verbal, a nonverbal, and a full-scale standardized score. The second improved version of the adapted WASI was used to test the children who participated in the ENAM project.

2.5 | Evaluation of ENAM follow-up participants

Mothers were interviewed at home, whereas adolescents were interviewed at school.

2.5.1 | Interview of mothers of participating households

Household and maternal background information, livelihood, use of iodized salt (0, 1), water and sanitation (0–3), socio-economic indicators (number of assets 0–10), and food insecurity using Food Insecurity Experience scale (0–8) were reported by the mothers during home visits. Information on their children's education was also obtained, and mothers gave permission to contact their child at school.

2.5.2 | Adolescent measures

The adolescent children were located in their respective schools and asked to sign assent before being individually administered tests. The testing was done in an isolated space of the school. The WASI-II subscales (number of items) were given in the following order: block design (13), vocabulary (31), matrix reasoning (30), and similarity (24) subscales. Practice items are given at the start of each scale so that respondents understand what is required. The 13-item block design subtest assesses visual-spatial reasoning; it uses cube blocks with red and white sides. Testees are shown three- and two-dimensional models using several blocks and are required to recreate the models with their own set of cubes. The vocabulary subtest assesses verbal expression; it has 31 items. The testee reads one word at a time and asked to give the meaning of the word (such as a car or enthusiastic). As part of the adaptation, more difficult words were replaced with local idiomatic expressions/proverbs. Each answer is scored 0 to 2 depending on how complete is the provided meaning. The matrix reasoning test assesses analytic reasoning with patterns and analogies. Three of four quadrants of a square have designs or pictures, and the testee is required to complete the pattern by choosing one of five presented options. There are 30 items scored 0 or 1. The similarity subtest assesses verbal reasoning and generation of abstract concepts. On each of 24 items, the testee is asked to state how two seemingly different items are alike. For example, blue and green are both colours. Answers are scored 0 to 2. For each subtest, because items become increasingly more difficult, testing stops after five consecutive failures.

2.5.3 | Other measures

Depressive symptoms are measured by the 20-item self-reporting questionnaire, which was developed by the World Health Organization (Beusenbergh, Orley, & World Health Organization, 1994) for developing countries and has previously been used in Ghana (Weobong et al., 2009). Dietary diversity was measured by a 24-hr food frequency questionnaire. This was analysed as a nine-group diversity score similar to the original ENAM data and as the conventional seven-group score. Anthropometric measurements including height, weight, mid-upper arm circumference, waist, and hip ratio were assessed. Goitre status was assessed by palpation method, and haemoglobin levels (using hemocue 301) were evaluated. Children with haemoglobin below 8 g/dl were referred to the nearest health centre. Education information of current grade, recent marks in Math and English, and overall marks (mean of marks in all subjects) were obtained from their school's assessment book.

2.6 | Analysis

Demographic characteristics of the ENAM and control participants were analysed to identify variables on which they differed; these were included as covariates. The raw scores of the WASI-II were then standardized using a WASI-II manual, and their concurrent validity was assessed using alpha and Pearson correlations with age, anthropometry, and school performance. Group differences between the intervention and comparison group for the primary outcomes (anthropometric indicators, school report scores, and raw and standardized WASI II scores) were then evaluated using cluster (community and school) adjusted ANCOVA (mixed model) controlling for confounders (sex, age, class, and research assistants) based on demographic differences between groups.

3 | RESULTS

Over half of the household heads (59%) had some form of education (formal or informal), and almost all had livestock (93%) but low assets meaning 0 to 4 out of 10 commodities (61%) with an average income of US\$ 23 a week and poor water and sanitation facilities (97%). Most used iodized salt (78%), and there was very little goitre among family members (1%). The caregivers' ages ranged from 26 to 84 years, over half of them had high parity (63%) and were married (65%) and had some form of education (50%). They were mostly local to the area (98%), lived in their spouses' house (72%), and were the biological mothers of the index child (82%). Over half of the adolescent children were males (62%), attended school, spoke mostly Kassena–Nankana language (73%), and as expected, their average age was 13.5 ± 1.08 . None of the children had goitre. Even though socio-economic indicators (assets and weekly cash) were higher in the intervention community, they were not significantly different. There was no significant demographic difference between the intervention and control families (Table 1).

TABLE 1 Mixed model and crosstabs comparing demographic variables and nutritional status of the intervention and control children

Variable	N	Total	n	Intervention	n	Control	t/F	p value
Caregiver								
Mother's age	110	45.49 ± 11.98	53	43.15 ± 10.22	48	46.65 ± 11.51	2.61	.109
Mother's education	107	0.50 ± 0.50	54	0.56 ± 0.50	44	0.43 ± 0.50	1.48	.227
Household								
WASH (3)	116	1.01 ± 0.16	55	1.02 ± 0.13	52	1.02 ± 0.14	0.00	.968
Assets (10)	116	6.14 ± 2.47	55	6.58 ± 2.42	52	5.81 ± 2.43	2.72	.102
Livestock (5)	116	3.22 ± 1.71	55	3.47 ± 1.74	52	3.06 ± 1.59	1.65	.201
Household head educ	110	0.59 ± 0.49	52	0.65 ± 0.48	50	0.56 ± 0.50	0.93	.337
Food insecurity (8)	116	6.31 ± 1.77	55	6.25 ± 1.90	52	6.42 ± 1.64	0.24	.625
Child								
Age	107	13.48 ± 1.08	55	13.38 ± 1.06	52	13.58 ± 1.11	0.86	.355
Class	107	6.00 ± 1.35	55	6.00 ± 1.14	52	6.00 ± 1.54	0.00	1.000
Nutritional status								
WHR	107	0.86 ± 0.06	55	0.86 ± 0.07	52	0.85 ± 0.06	0.36	.550
HAZ	107	-1.21 ± 1.20	55	-1.12 ± 1.15	52	-1.30 ± 1.26	0.53	.467
BFA	107	-0.69 ± 0.91	55	-0.69 ± 0.96	52	-0.70 ± 0.87	0.00	.989
MUAC	107	209.01 ± 25.48	55	204.52 ± 23.76	52	213.76 ± 26.60	3.60	.061
HB (g/dl)	107	12.35 ± 1.04	55	12.23 ± 1.08	52	12.47 ± 1.00	1.32	.253
Diversity (7)	105	5.09 ± 0.46	54	5.15 ± 0.53	51	5.02 ± 0.37	2.05	.155
Diversity E (9)	105	6.21 ± 1.24	54	6.75 ± 1.22	51	5.75 ± 1.09	15.96	.0001
Underweight	107	7(6.54)	55	5(4.67)	52	2(3.85)	1.20	.272
Stunting	107	28(26.17)	55	13(23.64)	52	15(28.85)	0.38	.540
Anaemia (Hb < 12 g/dl)	107	35(32.71)	55	19(34.55)	52	16(30.77)	0.17	.677

Note. Values are number (%) or mean ± SD. Mixed model was used for means and crosstabs for proportions.

Abbreviations: BFA, BMI-for-age z-score; Diversity E, dietary diversity as defined by the original Enhancing Child Nutrition through Animal Source Food Management project; HAZ, height-for-age z-scores; HB, haemoglobin; MUAC, mid-upper-arm circumference; WHR, waist-for-hip ratio.

3.1 | Psychometric properties of pretested WASI-II

To test the tools' reliability, the internal consistency in vocabulary improved from Cronbach's alpha coefficient $\alpha = .34$ to $\alpha = .80$, in similarity from $\alpha = .87$ to $\alpha = .62$, in block design from $\alpha = .55$ to $\alpha = .77$, and matrix reasoning $\alpha = .68$ remained at $\alpha = .68$. Thus, the final subtests were internally consistent in their assessment of children's intellectual function. Also, the test-retest reliability improved from the first to the second pretest, looking at stability of scores: During the first pretest, means for the four subtests were significantly different (test-retest differences ranged from 3.97 ± 4.07 to 34.47 ± 11.64 , $p < .05$), whereas at the second pretest test-retest, differences were nonsignificant (differences ranged from -7.33 ± 10.02 to 0.63 ± 6.72 , $p > .05$). Test-retest correlations also improved from the first pretest to the second, and at the second pretest looked reasonable except for matrix reasoning, which declined; for vocabulary (first pretest $r = -.03$; second pretest $r = .75$), similarity ($r = .24$; $r = .68$), block design ($r = .73$; $r = .98$), and matrix reasoning ($r = .72$; $r = .50$). The second WASI II tool was more reliable and showed better internal consistency so was used for the main data collection.

3.2 | Intercorrelations between WASI scores and other variables

Age correlated positively with raw intellectual functioning scores of the WASI, particularly on the verbal development subtests ($r = .19$ and $.27$, $p < .05$) and less so on nonverbal subtests ($r = .06$ and $.12$; Table 2). The children's ages were however negatively correlated with standardized verbal, nonverbal, and full scale scores ($r = -.06$ and $-.19$), meaning they were falling behind relative to age-mates as they got older. This is also commonly seen with anthropometric scores (age with height-for-age z-score, showing they are growing but not sufficiently to keep up with the standard).

There were also significant correlations between the intellectual functioning subscores and the child's school grade and other academic indicators (Table 2). The vocabulary score was associated with child's school grade; similarity score was associated with their school grade, marks in English and overall marks for all subjects. The block design score was associated with the child's marks in Mathematics and all subjects, and matrix reasoning was associated with all three academic marks. Likewise, WASI scores correlated as expected with

TABLE 2 Partial correlations between raw Wechsler Abbreviated Scale of Intelligence scores and physical growth, school performance, and depression

Variable	Block design	Vocabulary	Matrix reasoning	Similarity	Verbal std.	Nonverbal std.	Total score std.
Socio-economic							
Age	.12 (.230)	.27 (.005)	.063 (.520)	.19 (.046)	-.06 (.545)	-.19 (.048)	-.16 (.092)
Mothers educ.	-.08 (.471)	-.09 (.438)	-.10 (.337)	.13 (.214)	.02 (.850)	-.11 (.305)	-.07 (.508)
HHH educ.	-.14 (.176)	-.14 (.187)	-.19 (.075)	-.13 (.213)	-.15 (.169)	-.19 (.076)	-.21 (.043)
Assets	.05 (.592)	-.16 (.097)	-.04 (.715)	.04 (.703)	-.08 (.441)	.02 (.879)	-.04 (.661)
Emotional state							
Depression	-.23 (.028)	.02 (.835)	-.26 (.015)	-.18 (.087)	.14 (.191)	-.29 (.005)	-.11 (.280)
Academic							
Grade	.18 (.094)	.42 (<.0001)	.14 (.191)	.37 (.0003)	.48 (<.0001)	.19 (.071)	.41 (<.001)
Mathematics	.22 (.065)	.07 (.555)	.28 (.019)	.17 (.142)	.15 (.208)	.28 (.015)	.26 (.025)
English	.19 (.111)	.07 (.533)	.30 (.010)	.26 (.024)	.20 (.091)	.30 (.011)	.30 (.011)
All subjects	.23 (.042)	.10 (.415)	.26 (.024)	.33 (.004)	.27 (.023)	.28 (.015)	.33 (.004)
Nutritional status							
HAZ	-.13 (.237)	.12 (.275)	-.04 (.696)	.03 (.800)	.08 (.449)	-.10 (.325)	-.20 (.076)
BAZ	-.001 (.993)	.23 (.025)	-.06 (.602)	.24 (.025)	.27 (.010)	-.03 (.790)	-.14 (.203)
MUAC	-.07 (.563)	.24 (.021)	-.10 (.350)	0.13 (.231)	.24 (.021)	-.09 (.387)	-.07 (.511)
Diversity	-.18 (.098)	-.07 (.504)	-.06 (.574)	-.08 (.465)	-.10 (.341)	-.14 (.193)	-.14 (.208)
Diversity E	-.15 (.148)	-.05 (.628)	-0.03 (.795)	.10 (.357)	.02 (.859)	-.09 (.376)	-.04 (.728)
HB	.04 (.731)	.07 (.487)	-.03 (.744)	-.17 (.102)	-.05 (.636)	-.01 (.961)	-.02 (.821)

Note. *r* (*p* value). Partial age in all variables except age.

Abbreviations: BAZ, BMI-for-age z-score; Diversity E, dietary diversity as defined by the original Enhancing Child Nutrition through Animal Source Food Management project; HAZ, height-for-age z-scores; HB, haemoglobin; HHH, household head; MUAC, mid-upper-arm circumference; WHR, waist-for-hip ratio.

anthropometric indicators: The vocabulary, similarity, and combined verbal standardized scores were associated with BMI-for-age z-score. Nonverbal subtest scores were not correlated with anthropometric indicators but were negatively associated with the adolescents' depression symptoms.

Finally, the full-scale standardized score was associated with school grade and academic performance (English, Mathematics, and all subjects; $r = .26$ to $.33$; $p < .05$) but inversely associated with household head education ($r = -.21$; $p < .05$). The WASI-II tool showed acceptable internal consistency: The Cronbach's α for the raw verbal, similarity, block design, and matrix reasoning scores were 0.71, 0.69, 0.62, and 0.63, respectively.

3.3 | Comparison of ENAM children with controls

The average scores for the ENAM children in the site tested were low in all the subtests of the adapted WASI-II tool (71.11 ± 6.96). On the basis of analyses of covariance, adjusting for clusters, there were no significant differences between intervention and control adolescents across the four WASI-II subtests. Children in the control communities did slightly better than the intervention children on the WASI test but not significantly so (Table 3). The academic marks for mathematics,

English, and all subjects showed that on average, students were receiving passing marks. After adjusting for confounders (sex, grade, age, and research assistant) and clusters (community and school), the control children did better than the intervention children in mathematics and English (Table 3).

The prevalence of underweight was 6.5% and stunting rate was 26.2%. Their haemoglobin levels were within normal ranges with 32.5% being anaemic. There was no significant difference of anthropometric indicators and haemoglobin levels between those of the intervention and control communities ($p > .05$). However, the control children had significantly higher mid-upper-arm circumference when confounders and clusters were accounted for in a mixed model. Dietary diversity and symptoms of depression in the intervention adolescents were slightly higher than their controls but not significantly so when covariates and cluster were adjusted (adjusted means: 6.16 vs 5.95; 5.40 vs 5.52, respectively, $p > .05$).

4 | DISCUSSION

The effects of the ENAM intervention on anthropometric and SES indicators were not maintained 11 years later. The weekly women's group meeting to discuss the progress of their microcredit program,

TABLE 3 Mixed model analysis showing the intervention effect on socio-economic status, dietary intake, and physical and mental development after controlling for confounders

Variable	N	Intervention	Control	F	p value	ICC
WASI-II						
Block design (135)	100	11.22 ± 0.92	12.23 ± 0.82	0.56	.457	0.00
Vocabs (59)	100	23.99 ± 0.69	24.47 ± 0.62	0.26	.611	0.00
Matrix reasoning (30)	100	8.26 ± 0.72	8.19 ± 0.64	0.00	.945	0.05
Similarity(45)	99	18.15 ± 0.61	19.16 ± 0.56	1.31	.256	0.06
Standardized verbal (160)	99	78.04 ± 1.22	79.82 ± 1.08	1.07	.315	0.00
Standardized nonverbal (160)	100	65.6 ± 1.67	66.27 ± 1.49	0.06	.800	0.06
Standardized total score (160)	100	70.16 ± 1.14	71.06 ± 1.02	0.29	.589	0.05
Emotional state						
Depressive symptoms (20)	100	5.40 ± 0.59	5.52 ± 0.52	0.02	.885	0.00
Academic						
Mathematics (100)	83	53.77 ± 2.68	62.84 ± 2.45	5.94	.017	0.01
English (100)	85	55.19 ± 2.67	64.92 ± 2.42	6.73	.011	0.16
All subjects (100)	71	58.12 ± 2.62	64.88 ± 2.56	4.00	.049	0.11
Nutritional status						
WHR	100	0.85 ± 0.01	0.85 ± 0.01	0.02	.901	0.00
BMI	100	17.53 ± 0.29	18.01 ± 0.26	1.24	.269	0.06
HAZ	100	-1.09 ± 0.20	-1.06 ± 0.17	0.01	.923	0.00
BFA	100	-0.71 ± 0.14	-0.50 ± 0.13	1.13	.290	0.09
MUAC	100	206.32 ± 3.62	217.82 ± 3.23	4.75	0.032	0.18
HB	100	12.44 ± 0.19	12.30 ± 0.17	0.26	.610	0.01
FIS	100	6.30 ± 0.32	6.25 ± 0.29	0.01	.928	0.11
Diversity (0 to 7)	98	5.11 ± 0.08	5.06 ± 0.08	0.16	.691	0.00
Diversity (0 to 9)	98	6.16 ± 0.19	5.95 ± 0.17	0.60	.441	0.00

Note. Proc mixed: Outcomes against intervention, adjusted for confounders (sex, grade, age, and research assistant) and clusters (community by school attended).

Abbreviations: BFA, BMI-for-age z-score; Diversity 9, dietary diversity as defined by the original Enhancing Child Nutrition through Animal Source Food Management project; HAZ, height-for-age z-scores; HB, haemoglobin; MUAC, mid-upper-arm circumference; WHR, waist-for-hip ratio.

maintained by the rural banks, was still ongoing in intervention communities. There was however no nutritionist present to give nutrition education. It was refreshing to note that the microcredit model of the ENAM intervention had been adapted and maintained by the local rural bank. The trend showed higher but nonsignificantly different socio-economic indicators in the intervention communities compared with controls. The data also showed no significant demographic differences between the intervention and the control communities.

The adapted WASI-II showed acceptable internal consistency and test-retest reliability in the pretest indicating it was a reliable tool for this setting (Kramer et al., 2008). Raw scores showed a significant positive correlation with adolescents' age among pretested and ENAM participants, attesting to its concurrent validity as a measure of intellectual development. However, negative correlations between the standardized test scores and the children's age indicate a fall in their performance relative to their age-mates. This indicates the children were developing slower than their age-mates in higher-income countries. It is therefore not surprising that the average full-scale

intelligence score recorded among these adolescents was lower than the standard 100. This is also reflected in their growth rate with a stunting rate of 26%, which is higher than the national 18.8% rate (GSS, & Macro, 2015). Also, parental education is very low (50% had no formal or informal education), and the educational system in Northern Ghana is generally poorer than those in the South (Casely-Hayford, Alhassan Seidu, Quansah, & Kojo, 2013). Because comparisons were between groups within Ghana, the comparison of both raw and standardized scores is valid.

Validity of the WASI in this context was supported by the strong association with school grade, academic performance, and their growth indicators. Association between child growth (BMI-for-age) and intellectual functioning in low- and middle-income countries has been reported in the literature (Martorell et al., 2009; Walker et al., 2011).

In the Guinea Savanna zone of Ghana, we did not observe an intervention effect on the children's intellectual functioning, on their school performance, or on their growth in this follow-up study. Although the study has low power because of the small sample size, it was clear that

ENAM children did no better and on some tests worse than control children. The original ENAM study however saw a higher BMI-for-age, weight-for-age, and height-for-age z-scores among intervention children compared with their comparison group after 16 weeks of the intervention (Marquis et al., 2014). They also reported higher height-for-age in children living in the Guinea Savanna zone than Savanna Forest Transitional zone (LSM: -1.53 ± 0.10 vs -1.24 ± 0.11 ; $p = .03$). Mental development was not measured in the initial ENAM study. There is no immediate explanation why the intervention effects faded out, but explanations worth exploring include the following proposed by Barnett (2011):

1. Intervening and current nutritional and educational experiences may override earlier benefits;
2. Enhanced nutrition is insufficient to impact mental development in the long-term (Haddad et al., 2015);
3. Stimulation programs may have greater effect but even they may fade if stimulation is not maintained. Thus, nutrition by itself may be insufficient to maintain improved intellectual functioning in follow-ups of this length.

The adapted WASI-II and its good performance in assessing children's intellectual functioning are due to its careful adaptation in Ghana. It is therefore necessary that subsequent use of the tool considers the need for adaptation and assessment of reliability and validity. Three of the subtests (block design, matrix reasoning, and similarity) of the adapted tool used in this project can be used in low- and middle-income countries without many changes. Items in the vocabulary subtest however have to be modified for different settings and languages before use. In our study, the vocabulary had to be adapted to two different languages, with the latter items (items number 22 to 31) being a different format from the original. The local languages did not have a number of difficult, sophisticated, high-literacy words for assessment, and direct translations of the original words were not suitable. In our case, creating these word items required the assistance of an expert with tertiary education in languages. Finally, a limitation is that we did not standardize the WASI subtests for Ghana or obtain predictive validity, mainly because we were using them for research and not diagnostic purposes.

5 | CONCLUSION

The adapted WASI II tool successfully evaluated the intellectual functioning of adolescent children and the long-term effect of an agricultural, nutrition, and entrepreneurial training intervention on the participants' development in low- and middle-income country like Ghana. This study did not observe long-term ENAM intervention effects on child growth, intellectual functioning, school attainment, and performance after 11 years in one of its three agroecological sites with high stunting rate.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONTRIBUTIONS

Author HM was responsible for the final content for the project and was involved from the conception of the project to report write-up. FA was involved from the conception of the project to revision of the final report.

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