JNS
JOURNAL OF NUTRITIONAL SCIENCE

RESEARCH ARTICLE

The role of multi-dimensional women's empowerment in agriculture to improve the nutritional status of under-five children in rural cash crop producing, resource-limited settings of Ethiopia

Meskerem Jisso[1], Tizalegn Tesfaye[2], Sibhatu Biadgilign[3], Amare Abera Tareke[4]* and Tadesse Alemu Zerfu[2,5]

[1]*Department of Public Health, College of Medicine and Health Sciences, Hawassa University, Hawassa, Ethiopia*
[2]*College of Medicine and Health Sciences, Dilla University, Dilla, Ethiopia*
[3]*Public Health Nutrition Research Consultant, Addis Ababa, Ethiopia*
[4]*Department of Biomedical Sciences, College of Medicine and Health Sciences, Wollo University, Dessie, Ethiopia*
[5]*Global Academy of Agriculture and Food Security, Royal (Dick) School of Veterinary Studies, University of Edinburgh (UoE), Edinburgh, UK*

(Received 10 February 2022 – Final revision received 26 July 2022 – Accepted 31 August 2022)

Journal of Nutritional Science (2022), vol. 11, e92, page 1 of 9 doi:10.1017/jns.2022.86

Abstract

Little is known about the relation between the women empowerment in agriculture index, and health and nutrition outcomes among under-five children in Ethiopia. The study's objective was to examine women's empowerment in agriculture and its association with the nutritional status of children (6–59 months) in rural, cash crop producing, and resource-limited settings of Ethiopia. A community-based cross-sectional study was conducted employing 422 households; having women of reproductive age group and children under-five. Stratified simple random sampling was used to identify households; a simple random sampling was used to select villages and households. Women empowerment in agriculture was measured by the abbreviated women empowerment in agriculture index. Even if the overall multi-dimensional five domains of empowerment index (5DE) was not a significant predictor of nutritional status in children ($P > 0{\cdot}05$), sub-indicators had a pivotal role in child nutritional status. Disempowerment in decisions about input into production [AOR = 8·85], empowerment on control of income [AOR = 0·35] and availability of livestock [AOR = 0·38] were predictors of child stunting, whereas women's disempowerment in production decisions seems beneficiary for wasting, disempowered women have 84 % less likely to have wasted child than empowered women [AOR = 0·16]. Dietary and agricultural diversity [particularly livestock farming], and women's empowerment in production decisions were predictors of better nutritional outcomes in children. Therefore, a concentrated effort is needed towards strengthening the multi-dimensional empowerment of women in agriculture emphasising women's input into production decisions, dietary and agricultural diversification, mainly livestock farming.

Key words: **Child nutrition: Stunting: Wasting: Women empowerment in agriculture**

Background

People have the right to adequate food, and the right to be free of hunger under the international law. Food security exists when all people, at all times have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences[(1)]. Food and nutrition security is among the greatest challenges facing humanity in the present world[(2)]. Under-five children are the main victims of food

Abbreviations: A-WEAI: Abbreviated Women's Empowerment in Agriculture Index; DE: Domain of Empowerment; HAZ: height for age; LAZ: length for age; SRS: simple random sampling; WLZ: weight for length; WHO: World Health Organization

* **Corresponding author:** Amare Abera Tareke, email amareabera8@gmail.com

insecurity with devastating consequences in the future generation. Despite the progress in preventing and treating child undernutrition, 5 million annual deaths occurred in under-five children worldwide, nutrition-related problems account for almost half of the deaths[3,4]. Sub-Saharan Africa carry the highest burden of child malnutrition, besides the East and West African subregions are highly affected by stunting and wasting[5]. In Ethiopia, child malnutrition remained one of the major public health problems which account 51 % of all childhood deaths[6]. According to the Ethiopian Mini Demographic and Health Survey (EMDHS) 2019 report, the prevalence of stunting and wasting remained to be one of the highest in the world at 49 and 8 %, respectively. This prevalence is predominant in rural areas, where access to improved food sources, health facilities and other infrastructure is very limited[7,8].

Current strategies to address these problems focus on nutrition-specific interventions targeting mothers and children. The programmes aimed at intervening in major underlying factors like women's empowerment, food systems, socio-economic factors and disease prevention[9]. As farming is the primary food and income source for the ever-increasing African population[10], rapid agricultural transformation is the only way out to reach to the targets and achieve food security by 2030[11]. One of the mechanisms was nutrition-sensitive agriculture. Nutrition-sensitive agriculture will narrow the gap between available and accessible food and the food needed for a healthy and balanced diet for all people, it also promotes food and nutrition sovereignty by promoting access to an affordable, diversified and more adequate diet[12,13].

On the other hand, one of the reasons why agriculture in sub-Saharan Africa is underperforming is mainly because women, who represent a crucial resource in agriculture and the rural economy through their multiple roles as farmers, labourer's and entrepreneurs, face more severe constraints than men in access to productive resources[14]. Likewise, it is important to unlock this and other critical bottlenecks to empower women to ensure rapid agricultural transformation in Africa[15].

There is now greater urgency to close gender gaps to empower women and young girls especially in vulnerable settings. Women are active agents of economic and social change, they play crucial roles ensuring food and nutrition security, eradicating rural poverty and improving the well-being of their families yet continue to face serious challenges as a result of gender-based stereotypes and discrimination that deny them equitable access to opportunities, resources, assets and services[16]. Women empowerment is important not only for women but also reducing poverty and anger, improving health and nutrition[17]. Studies show that women make essential contributions to the agricultural and rural economies in all developing countries by increasing agricultural performance[18]. Recent intervention strategies focusing on developmental indicators (such as child and household nutrition, poverty alleviation, education and improving investments in human capital) are considering women's empowerment as a determinant factor[19].

To end hunger by 2030, and to meet the sustainable development goal, the Ethiopian government implemented the National Nutrition Program. The overall goal of the programme was to facilitate and ignite the accelerated reduction of malnutrition. The main strategy was an integrated approach linking between nutritional needs and improvement of agriculture/animal breeding/fisheries and aquaculture sectors. The interventions under this programme include: optimal breastfeeding; optimal complementary feeding; mitigation and prevention of micro-nutrient deficiencies; water sanitation and hygiene; deworming; food fortification and management of acute malnutrition[20].

Despite the important roles they play in agricultural economies, rural women in Africa suffer from the highest illiteracy rates and are the most visible face of poverty[21]. Women in Africa have less access and control over all land and productive resources[14]. This is mainly attributable to lack of tailored and evidence-based strategies, programmes, policies or limitations of existing policies which are either misdirected or insufficient to high levels of poverty and illiteracy. Moreover, non-involvement of rural women in the design and planning of agricultural programmes and policies in order to reflect the real and specific needs is also another challenge.

Though new evidences are emerging on the association between women empowerment and child nutrition, there is a scarcity of data relating the index to child health and nutrition outcomes. Few published studies explored Abbreviated Women's Empowerment in Agriculture Index (A-WEAI) associated with child height-for-age (HAZ) but not with weight-for-height (WHZ) using cross-sectional designs[22–25]. Therefore, the present research aims to fill these gaps through the generation of empirical evidence between women empowerment in general and components of the five domains of A-WEAI empowerment index (5DE) and the association with nutritional status of children[26].

Methods

Study setting and design

A community-based cross-sectional study using a multi-sectoral and multi-disciplinary study tool (A-WEAI) was conducted in selected rural districts of the Gedeo zone, Southern Nations, Nationalities, and Peoples' Region, Ethiopia from 1 February 2019 to 15 August 2019. The zone has six districts[27] and is well known for its indigenous agroforestry. It is unique for its exceptional mixed cultural and natural landscape[28] that allowed the land to carry the highest population density in Africa[29]. On the other hand, it is also known for unacceptably high (54 % stunting and 15–27 % wasting) rate of child undernutrition and gender-based violence (84 % lifetime prevalence of intimate partner violence)[30] (Fig. 1).

Sample size and sampling

We used a single population proportion formula considering the following parameters: 95 % confidence level, 9·2 % Proportion of empowered women (P) for overall A-WEAI 5DE based on a similar study in rural Nepal[32] and margin of error of 2 % for overall A-WEAI 5DE (as it is a rare event). Adding, 10 % for possible non-response rate and

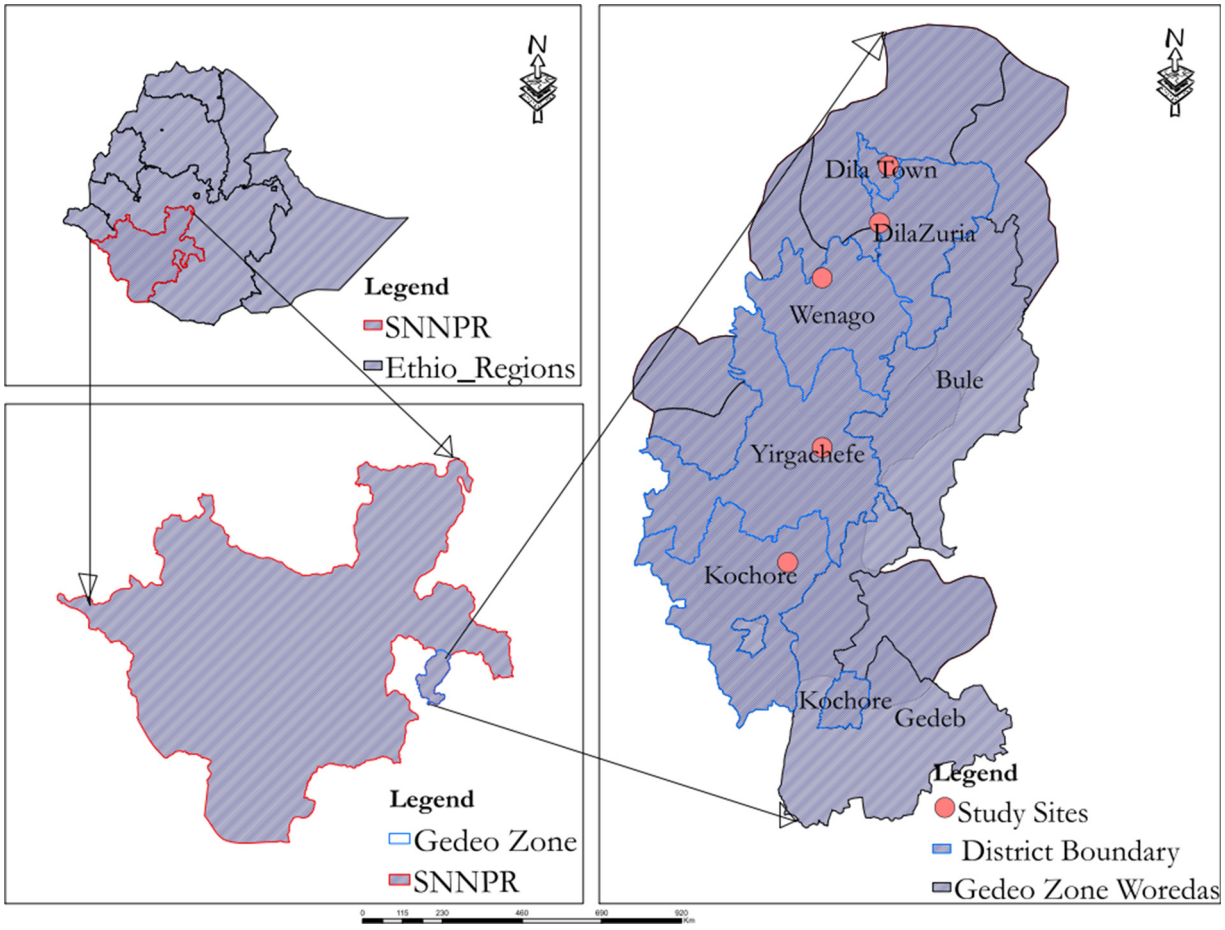

Fig. 1. Map of the study area taken from Molla *et al.*[31]

multiplying by 1·5 design effect, the total sample size required for the study is 428.

Since the present study aimed to study rural areas, six districts of the zone were eligible for this study. We selected two districts from the rural areas by simple random sampling. The same sampling technique was applied to select six kebeles from the two districts (three kebeles per each district).

Following this, the list of all households having under-five children was obtained from the Kebele administrator in consultation with local health extension workers and health development army representatives. Study subjects fulfilling the criteria were allocated proportional to each kebele's household size.

All mothers/caretakers (15–49 years) and all children (6–59 months) in the household of selected districts were eligible for the study. Out of the six rural districts in the Gedeo zone, two was drawn randomly using a lottery method and in 428 randomly selected households, all mothers/caretaker (15–49 years) and children (6–59 months) of selected households were studied.

Data collection procedure

We used a pre-tested structured interviewer-administered A-WEAI questionnaire for collecting multi-sectorial women's level of empowerment. The questionnaire used for the survey includes modules on basic demographic information; household consumption expenditure; women empowerment indicators; dietary diversity; child anthropometry and infant and young child feeding; employment, agricultural productivity and input use; and other relevant information. The questionnaire was prepared in English and then translated to Amharic and Gedeufa languages and back translated to English to maintain consistency.

Anthropometric assessment

Duplicate measurements of child weight and height (supine length of children) were taken using standardised calibrated digital weighing scales (Seca GmbH & Co. KG, model 881 1021659; precision ± 100 g) and height/length boards. Child age was derived from maternal recall or, when available, from a birth certificate. HAZ and WHZ were computed using the WHO growth reference. Children with length-for-age or WHZ below −2 SD from the median of the reference population (HAZ < −2 or WHZ <−2) was classified as stunted or wasted, respectively[33]. HAZ and weight-for-age (WAZ) *Z*-scores were computed using the World Health Organization (WHO) growth reference computed using the AnthroPlus software.

Measurement for scoring the A-WEAI

The 5DE (Table 1) is measured by a number ranging from zero to one, with higher levels indicating greater

empowerment. The score has two components. First, it reflects the percentage of women who are empowered (He). Second, it reflects the percentage of domains in which those women who are not yet empowered (Hn) already have adequate achievements. In the 5DE formula, Aa is the percentage of dimensions in which disempowered women have adequate achievements:

$$5DE = He + Hn\,(Aa), \text{ where } He + Hn = 100\% \text{and } 0 < Aa < 100\%.$$

This can also be written, following the Alkire Foster methodology[34,35], as $\{1-(H \times An)\}$, where $A = (1a)$ and reflects the percentage of domains in which disempowered women on average do not have adequate achievements.

Operational definitions

- *Stunting*: Height-for-age less than −2 *Z*-score based on the WHO reference group.
- *Wasting*: Weight-for-height less than −2 *Z*-score based on the WHO reference group[33].
- *Body mass index (BMI)*: calculated by dividing weight in kilograms by the square of height in metres. A woman or man is classified as overweight if he/she has a BMI of 25·0 or greater, and obese if a BMI of 30·0 or greater and underweight if he/she has a BMI less than 18·5[36].
- *Adequate dietary diversity*: represents children meeting the minimum level of dietary diversity. This means they have consumed ≥4 food groups during the previous day. The food groups incorporated in computing dietary diversity was: (1) Grains, roots and tubers, (2) Legumes and nuts, (3) Dairy products (infant formula, milk, yogurt, cheese), (4) Flesh foods (meat, fish, poultry and liver/organ meats), (5) Eggs, (6) Vitamin A-rich fruits and vegetables and (7) Other fruits and vegetables.
- *Inadequate dietary diversity*: represents children who did not meet the minimum dietary diversity level. This means they have consumed <4 food groups during the previous day.
- *Food secure HH*: If the respondent answers 'No' to all, or 'Yes' for only one of the eight standard questions of the Household Food Insecurity Experience Scale (HHFIES), has acceptable levels of internal validity for use in SSA[37].
- *Food insecure HH*: If the respondent answers 'Yes' to at least two of the questions of the HHFIES.
- *Access to safe water*: If the household has improved water sources as defined in[38].
- *Access to latrine*: Household has any type of latrine.

Statistical analysis

A statistical analysis was done using Stata version 14 statistical software. Children not measured or with anthropometric *Z*-score values outside the biologically plausible range (HAZ ⟨−6/⟩6 and WHZ ⟨−5/⟩5); were excluded from analysis, as recommended by the WHO. The associations between each of the six indicators of women's empowerment in agriculture and child HAZ and WHZ were tested using ordinary least-squares bivariate and multivariate regression analyses after controlling for district-level clustering. For each of these linear regressions, the dependent variable was the *Z*-score and the independent variables were the dichotomous empowerment variables. In multivariate logistic regressions, data were also adjusted for various child, maternal and household factors that could confound the relationship between women's empowerment in agriculture and child nutritional status based on prior literature review of similar studies and our knowledge of the local context.

Ethical considerations

Ethical approval was sought from Dilla University College of Medicine and Health Science Institutional Review Board (IRB). Investigators were certified on ethical principles from the National Institutes of Health (NIH). Investigators and all research assistants were ensured all ethical principles of the latest Helsinki declaration ethical principles for medical research involving human subjects. Confidentiality, beneficence and privacy were cornerstones of the ethics and ensured. For data collected from children, assent was made and consent from guardian/parents was obtained before any study activities.

Results

Participant description

A total of 428 households were sampled for participation, 422 households gave responses, yielding a response rate 98·6 %. Accordingly, it was found that the mean (±SD) age of children enrolled to the study was 25·1 (±13·5) months; whereby nearly

Table 1. Domains used to compute the Women's Empowerment in Agriculture Index[35]

Domain	Indicator	Definition
Production	Decisions on production	Sole or joint decision-making over food and cash crop farming, livestock.
Resources	Ownership of assets/ access to and decisions on credit	Sole or joint ownership of major household assets. Asset disposal and acquisition. Does woman participate in decisions to buy, sell or transfer assets? Access to and decisions on credit. Access to credit and participation in decisions concerning credit.
Income	Control over use of income	Sole or joint control over income and expenditures.
Group membership	Group membership	Is woman an active member in at least one economic or social group, e.g. agricultural marketing?
Time	Workload	Allocation of time to productive and domestic tasks. The individual is defined as adequate on workload if the number of hours he or she worked per day was less than the time poverty line of 10·5 h in the previous 24 h.
Overall WEAI	5 Domains of Empowerment	The empowerment in the overall WEAI 5DE percentage represents an individual who, based on these indicator level cut-offs, is empowered in some combination of the weighted indicators reflecting at least 80 % total adequacy.

two-thirds (64·1 %) of them were older children aged between 18 and 24·9 months. Less than half (47·2 %) were boys and only a quarter (25·8 %) had adequate dietary diversity (≥4 food groups). The mean (±SD) HAZ and WHZ *Z*-scores were 0·42 (±0·49) and 0·76 (±0·43), respectively. Approximately three in five (57·6 %) children aged 6–59 months appeared to suffer from chronic undernutrition (stunting) and one in four (23·8 %) children in the study area was acutely malnourished (wasted) (Table 2).

Women's empowerment, maternal and household characteristics and child nutritional status

Among maternal and household characteristics, younger (12–18 months) and older (19–59 months) children ($P < 0·05$); children born to mothers in their twenties ($P < 0·05$) or to a small household size ($P < 0·05$); children of families owning one or none livestock in the house ($P < 0·05$); children who have inadequate dietary diversity ($P < 0·001$) and those children whose families having no access to latrine ($P < 0·001$) had higher stunting compared to their counterparts. Nonetheless, women empowerment in agriculture had no significant association with childhood stunting ($P = 0·58$) (Table 3).

Similarly, a bivariate analysis of the *Z*-scores for HAZ and WHZ have also showed a statistically significance association between input into production decisions, control over resources, control over use of income and group membership with childhood stunting ($P < 0·05$). However, only empowerment dimensions of input into production decisions and resources were statistically significant with childhood wasting ($P < 0·05$) (Table 4).

Multivariate analysis of WEAI and nutritional status of children

From variables fitted to the multivariable regression model, three variables were found to be independently associated with childhood stunting and only one variable associated with childhood wasting. As such, children whose mother is disempowered on input into production decisions were nine times more likely to be stunted than empowered women [AOR = 8·85; 95 % CI (3·66, 21·39)]. On the other hand, those children whose mother is disempowered for control over income were 65 % less likely to have stunted child than their counterparts [AOR = 0·35, 95 % CI (0·16, 0·75)]. Whereas, families who own between 2 and 3 livestock were 62 % less likely to have stunted child than households who have less than equal to one livestock [AOR = 0·38; 95 % CI (0·18, 0·80)]. Interestingly, women disempowerment in production decisions seems beneficiary for wasting, disempowered women have 84 % less likely to have wasted child than

Table 2. Selected child and household characteristics of the sample, by 5DE inclusion status; children under 59 months of age and their mothers (*n* 422) in rural Gedeo, August 2019

Variable	Number/Mean	% (SD)
Child Characteristics		
Age (months) – Mean (SD)	422	25·1 (13·5)
Age group (%)		
6–11·9	56	13·3
12–17·9	96	22·7
18–23·9	44	10·4
24–59	226	53·6
Sex: boys (%)	199	47.2
Anthropometric *Z*-scores		
Height-for-age *Z*-score – Mean (SD)	0·42	0·49
Stunting prevalence (%)	57·6	
Weight-for-height *Z*-score – Mean (SD)	0·76	0·43
Wasting prevalence (%)	23·8	
Dietary diversity – Mean (SD)	3·62	1·36
Inadequate [DDS <4] (%)	313	74·2
Adequate [DDS >=4] (%)	109	25·8
Household Characteristics		
Household size – Mean (SD)	6·5	1·6

SD, standard deviation; DDS, dietary diversity score.

Table 3. Bivariate associations between child, maternal and household characteristics and stunting among children 6–59 months of age (*n*) in rural Gedeo, southern Ethiopia, August 2019

Variable	Stunted *N* (%)	Non-stunted *N* (%)	*P*-value
Children's age group (months)			
6–11·9	23 (41·1)	33 (58·9)	
12–17·9	50 (52·1)	46 (47·9)	0·02*
18–23·9	36 (81·8)	8 (18·2)	
24–59	134 (59·3)	92 (40·7)	
Child's sex			
Boys	116 (58·3)	83 (41·7)	0·43
Girls	127 (57)	96 (43)	
Maternal height			
<148 cm	10 (43·5)	13 (56·5)	0·12
≥148 cm	233 (58·4)	166 (41·6)	
Maternal age (years)			
20–29	89 (65·9)	46 (34·1)	
30–39	148 (53·2)	130 (46·8)	0·043*
40–49	6(66·7)	3 (33·3)	
Household size (members)			
1–4	28 (73·7)	10 (26·3)	0·04*
5–7	164 (58·2)	118 (41·8)	
8+	51 (50)	51 (50)	
Number of U5 Children in the HH			
≤1	234 (56·9)	177 (43·1)	0·18
2–3	8 (80)	2 (20)	
4+	1 (100)	0 (0)	
Women empowerment			
Empowered	9 (60)	6 (40)	0·58
Disempowered	232 (58·9)	162 (41·1)	
Livestock Density in the HH			
≤1	139 (63·2)	81 (36·8)	0·03*
2–3	25 (50)	25 (50)	
4+	79 (52)	73 (48)	
Dietary Diversity Score			
<4 (Inadequate)	206 (65·8)	107 (34·2)	0·001*
≥4 (Adequate)	37 (33·9)	72 (66·1)	
Received Vitamin A			
No	62 (51·7)	58 (48·3)	0·08
Yes	181 (59·9)	121 (40·1)	
Own at least one livestock in the HH			
No	104 (65·4)	55 (34·6)	0·007*
Yes	139 (52·9)	124 (47·1)	
Have access to safe water			
No	118 (55·4)	95 (44·6)	0·21
Yes	125 (59·8)	84 (40·2)	
Have access to latrine (any)			
No	29 (93·5)	2 (6·5)	0·001*
Yes	214 (54·7)	177 (45·3)	

HH, household.
* Significant at $P < 0·05$.

Table 4. Bivariate associations between maternal empowerment with HAZ and WHZ among children 6–59 months of age (*n* 422) in rural Gedeo, August 2019

		HAZ		WHZ	
A-WEAI	*n*	Mean (SE)	*P*-value	Mean (SD)	*P*-value
Overall A-WEAI					
Empowered	15	−2·56 (3·54)	0·57	0·78 (0·11)	0·86
Disempowered	394	−3·13 (3·89)		0·76 (0·02)	
Input into production decisions					
Empowered	253	−1·76 (0·23)	0·001*	0·69 (0·03)	0·001*
Disempowered	133	−5·78 (0·23)		0·92 (0·02)	
Resources					
Empowered	167	−2·23 (0·26)	0·001*	0·67 (0·03)	0·001*
Disempowered	228	−3·73 (0·28)		0·85 (0·02)	
Control over use of income					
Empowered	193	−2·64 (0·25)	0·049*	0·73 (0·03)	0·15
Disempowered	205	−3·42 (0·29)		0·79 (0·03)	
Group membership (Leadership)					
Empowered	207	−2·49 (0·23)	0·04*	0·73 (0·03)	0·25
Disempowered	174	−3·31 (0·35)		0·78 (0·03)	
Time (Workload/ Leisure)					
Empowered	66	−3·37 (0·44)	0·39	0·76 (0·05)	0·94
Disempowered	296	−2·92 (0·22)		0·76 (0·03)	

* Indicates significant association. The table depicts bivariate association between child nutritional status and indicators of A-WEAI. In bivariate association using ordinary least-square method; input into production decisions, resources, control over use of income and group membership were predictors of stunting. On the other hand, input into production decisions and resources were indicators of A-WEAI associated with wasting.

empowered women [AOR = 0·16; 95 % CI (0·05, 0·48)] as indicated in Table 5.

Discussion

The present study was conducted to examine the role of multi-dimensional women's empowerment in agriculture in improving child nutrition. It turns out that the prevalence of undernutrition was high. The study revealed that children whose mother is disempowered on input into production decisions and for control over income and families who own between 2 and 3 livestock were less likely to have stunted child than their counterparts. Women disempowerment in production decisions seems beneficiary for wasting than empowered women. Different domains may have different impact on nutrition, because gender norms are culture and context-specific. WEAI domains in different countries were important in different settings[39].

The prevalence of stunting and wasting in the area was 57·6 and 23·8 %, respectively. The stunted percentage of children was almost comparable with neighbouring study in Halaba, and a bit higher of Zeway, 54 and 42 %, respectively[40]. But, the figure in both stunting and wasting was higher than the national figure; results from 2019 EMDHS show 49 % of under-five children were stunted and 8 % were wasted[41]. Nutritional status in children was tied to maternal nutritional status during adolescence, pregnancy and breastfeeding periods, communities cultural background, women's empowerment, socio-economic factors and infectious diseases[42].

Among the domains of women empowerment, input into production decisions was a decisive factor. We found that children whose mother is disempowered on input into production decisions were nine times more likely to be stunted than empowered women. Those children from disempowered mother over control of income were 65 % less likely to have stunted child than their counterparts. Whereas, families who have livestock density between 2 and 3 were 62 % less likely to have stunted child than households who have less than equal to one livestock. Women empowerment as measured by the five domains of empowerment (5DE) is significantly associated with better HAZ *Z*-scores for children aged between 6 and 59 months[43]. Empowerment in production decisions, control over income and livestock density were factors affecting stunting. When women empowered to make production decisions about food production, crop production and livestock raising, they may make decisions in favour of the nutritional needs of young children compared to these decisions are out of their hand by their spouse or pressured by the community[32,42].

Women empowerment in control over income improved children nutritional status generally and stunting in particularly. Control over income has found to have negative association with stunting[44,45], mothers with greater control over expenditures were more likely to have children with better long-term nutritional status evidenced by stunting status of their children[25]. Mothers who can use money as their wish tend to spend it on their child's welfare. Mothers' financial resources were important for children's growth regardless of women social status in different societies[45].

Interestingly, women disempowerment in production decisions seems to promote wasting, disempowered women have 0·16 times less likely to have wasted child than empowered women. Though this finding disagrees with previous studies, the possibility of less care to their children of empowered women should not be ruled out. Empowered women might also spend their time out of the household giving less time to their children's nutrition. Seasonal variations and consequently maternal habits (i.e. women tend to drink alcohol in groceries in the study area) could affect children's nutritional

Table 5. Multivariate associations between women's empowerment in agriculture and nutritional status among children 6–59 months of age in rural Gedeo, August 2019

A-WEAI	Stunting AOR (95 % CI)	Wasting AOR (95 % CI)
Overall A-WEAI 5DE		
Empowered	1	1
Disempowered	0·71 (0·16, 3·27)	0·87 (0·14, 5·42)
Input into production decisions		
Empowered	1	1
Disempowered	8·85 (3·66, 21·39)*	0·16 (0·05, 0·48)*
Resources		
Empowered	1	1
Disempowered	0·84(0·43, 1·67)	0·72 (0·33, 1·54)
Control over use of income		
Empowered	1	1
Disempowered	0·35 (0·16, 0·75)*	2·17 (0·95, 4·96)
Group membership (Leadership)		
Empowered	1	1
Disempowered	1·34 (0·69, 2·59)	0·48 (0·22, 1·04)
Time (Workload/Leisure)		
Empowered	1	1
Disempowered	1·06 (0·39, 2·81)	1·83 (0·62, 5·46)
HH Food Insecurity		
Yes	1	1
No	0·97 (0·34, 2·77)	2·16 (0·65, 7·19)
Dietary Diversity Score		
Inadequate (<4 DDS)	1	1
Adequate (>=4 DDS)	0·72 (0·37, 1·41)	0·69 (0·32, 1·49)
Access to safe water		
No	1	1
Yes	0·66 (0·34, 1·31)	2. 87 (1·29, 6·35)
Livestock density Score		
≤1	1	1
2–3	0·38 (0·18, 0·80)*	2·03 (0·88, 4·69)
4+	0·62 (0·24, 1·57)	0·75 (0·28, 2·01)
Child age		
6–11·9	1	1
12–17·9	2·08 (0·89, 4·79)	1·47 (0·54, 3. 97)
18–23·9	1·45 (0·73, 2·89)	0·69 (0·31, 1·40)
24–59	0·76 (0·24, 2·41)	0·87 (0·24, 3·15)
Child sex		
Male	1	1
Female	0·93 (0·52, 1·67)	0·53 (0·27, 1·01)

*Indicates *P*-value less than 0·05. Multivariate logistic regression indicates the association of nutritional status in children and A-WEAI indicators as well as other child and maternal characteristics. Empowerment in input into production decisions, control over use of income and livestock density were associated with stunting, while input into production decisions was the only variable associated with child wasting.

status in short period. This association of acute undernutrition with disempowerment in production decisions should be verified in different seasons of the year.

Livestock resources were determinant over nutritional status of the children. But this crucial role of livestock resource on child nutrition is overly threatened by women's control over resources and income of the household[46]. While food insecurity is the main driving factor for chronic undernutrition, livestock ownership provides some protection to the sustained food security of the household and children. Small ruminants accelerate child growth and were associated with initial height trajectory. Livestock ownership shown to be crucial to remote households with limited access to purchased foods, where it become the only sources of certain nutrients[46,47].

Livestock ownership through animal source food consumption could be the primary source of high-quality protein and key micronutrients, which are especially important young children's health and development[48–53]. On the other hand, livestock ownership is contributing to household income, is becoming increasingly important in developing countries as the level of development improves[54,55]. Given the incipient link between livestock production and better nutritional outcomes, livestock farming is frequently encouraged as a means of expanding children's access to and consumption of high-quality animal source food worldwide[49,54,56]. This could be related to the fact that livestock ownership can provide households with greater opportunities to boost animal source food consumption if it results in cheaper or more reliable food supply[49]. This is particularly likely when markets are underdeveloped, especially for perishable products like milk and dairy, which require expenditures in refrigeration and other equipment that may not be economically justifiable in the face of low effective demand.

In conclusion, the multi-dimensional women's empowerment in agriculture index was not significantly associated with nutritional status of under-five children. Disempowerment on input into production decisions and control over income were among the domains negatively affect child nutritional status. Disempowered women on these two domains tend to have higher stunting rates of their children. Household livestock density shown to be crucial to remote households with limited access to purchased foods, where it becomes the only sources of certain food groups and nutrients.

Strengthen the level of empowerment of women about input into production decisions that give the opportunity for women to make a self or joint decision-making over food and cash crop farming as well as ownership of major household assets. Concerned bodies, to their levels and scopes, need to pay attention to all aspects and domains of women empowerment in agriculture, but a special attention should be paid to their time allocation to productive and domestic tasks. Cash producing farmers in rural Ethiopia could benefit from diversified their agriculture, particularly from livestock farming. Government and other stakeholders should also emphasise agricultural diversification in rural cash crop producing areas to end the unacceptably high level of undernutrition (stunting and wasting).

Acknowledgements

The authors acknowledge the study participants and Tufts University.

The data that support the findings of this study are available from the corresponding author upon reasonable request.

T. A. Z. conceived and designed the study; T. A. Z. and M. J. conducted the research and performed statistical analysis. T. A. Z., M. J. and A. A. T. wrote the paper. S. B., T. T., and A. A. T. read, edited, and cleaned the draft. All authors have read and approved the final manuscript.

This work is supported by Tufts University under small research grant.

All authors declare no conflicts of interest.

Ethical approval was sought from Dilla University College of Medicine and Health Science Institutional Review Board

(IRB) [ref no 007/2018]. For data collected from children, assent was made and consent from guardian/parents was obtained before doing the study activities.

References

1. Kent G (2005) *Freedom from Want: The Human Right to Adequate Food*, p. 300. Washington, DC: Georgetown University Press.
2. FAO, IFAD & WFP (2015) *The State of Food Insecurity in the World: Meeting the 2015 International Hunger Targets: Taking Stock of Uneven Progress*, pp. 1–54. Rome: FAO, IFAD and WFP.
3. WHO (2018) Children: reducing mortality [Internet]. Available at https://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality (cited 10 June 2020).
4. Black RE, Victora CG, Walker SP, *et al.* (2013) Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet* **382**, 427–451.
5. Akombi BJ, Agho KE, Merom D, *et al.* (2017) Child malnutrition in sub-Saharan Africa: a meta-analysis of demographic and health surveys (2006–2016). *PLoS One* **12**, e0177338.
6. ETH (2013) National Nutrition Programme.pdf [Internet]. Available at https://extranet.who.int/nutrition/gina/sites/default/files/ETH%202013 %20National%20Nutrition%20Programme.pdf (cited 4 June 2020).
7. Fantay Gebru K, Mekonnen Haileselassie W, Haftom Temesgen A, *et al.* (2019) Determinants of stunting among under-five children in Ethiopia: a multilevel mixed-effects analysis of 2016 Ethiopian demographic and health survey data. *BMC Pediatr* **19**, 176. doi:10.1186/s12887-019-1545-0.
8. Hirvonen K (2016) Rural–urban differences in children's dietary diversity in Ethiopia: a Poisson decomposition analysis. *Econ Lett* **147**, 12–15.
9. Bhutta ZA, Das JK, Rizvi A, *et al.* (2013) Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? *Lancet Lond Engl* **382**, 452–477.
10. FAO (2009) *Global Agriculture Towards 2050*, pp. 1–4. Rome: High Level Expert Forum-Feed World 2050.
11. OECD/FAO (2016) OECD agriculture statistics. In *OECD-FAO Agricultural Outlook 2016–2025*. Paris: OECD (OECD-FAO Agricultural Outlook). Available at https://www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook-2016_agr_outlook-2016-en (cited 4 June 2020).
12. Jaenicke H & Virchow D (2013) Entry points into a nutrition-sensitive agriculture. *Food Secur* **5**, 679–692.
13. Maluf RS, Burlandy L, Santarelli M, *et al.* (2015) Nutrition-sensitive agriculture and the promotion of food and nutrition sovereignty and security in Brazil. *Ciênc Saúde Coletiva* **20**, 2303–2312.
14. Hazell PBR (2017) Africa agriculture status report: the business of smallholder agriculture in Sub-Saharan Africa. *Alliance Green Revolut Afr AGRA* **5**, 3–19.
15. FAO (2009) *The Special Challenge for sub-Saharan Africa*, p. 4. Rome: High-Level Expert Forum Feed World 2050.
16. UN Women watch (2012) The UN System: Working Together to Empower Rural Women [Internet]. Available at https://www.un.org/womenwatch/feature/ruralwomen/ (cited 22 June 2022).
17. Shenggen F, Sivan Y & Rajul PL (2019) Agriculture for improved nutrition: seizing the momentum. *Int Food Policy Res Inst* **233**, 58–67.
18. Diiro GM, Seymour G, Kassie M, *et al.* (2018) Women's empowerment in agriculture and agricultural productivity: evidence from rural maize farmer households in western Kenya. *PLoS One* **13**, e0197995.
19. Tsiboe F, Zereyesus YA, Popp JS, *et al.* (2018) The effect of women's empowerment in agriculture on household nutrition and food poverty in northern Ghana. *Soc Indic Res* **138**, 89–108. doi:10.1007/s11205-017-1659-4.
20. UNEP. National Nutrition Program (NNP II) 2016–2020 [Internet]. Available at https://leap.unep.org/countries/et/national-legislation/national-nutrition-program-nnp-ii-2016-2020 (cited 8 February 2022).
21. Akter S, Rutsaert P, Luis J, *et al.* (2017) Women's empowerment and gender equity in agriculture: a different perspective from Southeast Asia. *Food Policy* **69**, 270–279.
22. Malapit HJL & Quisumbing AR (2015) What dimensions of women's empowerment in agriculture matter for nutrition in Ghana? *Food Policy* **52**, 54–63.
23. Cunningham K, Ruel M, Ferguson E, *et al.* (2015) Women's empowerment and child nutritional status in south Asia: a synthesis of the literature. *Matern Child Nutr* **11**, 1–19.
24. Sraboni E, Malapit HJ, Quisumbing A, *et al.* (2014) Women's empowerment in agriculture: what role for food security in Bangladesh? *World Dev* **61**, 11–52.
25. Malapit HJL, Kadiyala S, Quisumbing AR, *et al.* (2015) Women's empowerment mitigates the negative effects of low production diversity on maternal and child nutrition in Nepal. *J Dev Stud* **51**, 1097–1123. doi:10.1080/00220388.2015.1018904.
26. UNICEF Ethiopia (2016) *New National Nutrition Programme II Envisions an Ethiopia Free of Malnutrition – UNICEF Ethiopia*. Press Release.
27. Federal Democratic Republic of Ethiopia; Population Census Commission (2008) *Summary and Statistical Report of the 2007 Population and Housing Census; Population Size by Age and Sex*. UNFPA, Addis Ababa, Ethiopia.
28. Talemos S, Abreham A, Fisseha M, *et al.* (2013) Distribution status and the impact of parthenium weed (*Parthenium hysterophorus* L.) at Gedeo Zone (Southern Ethiopia). *Afr J Agric Res* **8**, 386–397.
29. UN DESA (2015) *World Population Expected to Reach 9.7 Billion by 2050*, pp. 1–3. New York: United Nations Department of Economic and Social Affairs.
30. Bogale B, Wondafrash M, Tilahun T, *et al.* (2011) Married women's decision making power on modern contraceptive use in urban and rural southern Ethiopia. *BMC Public Health* **11**, 342.
31. Ba E, Behaksra S, Tadesse F, *et al.* (2021) Past eight-year malaria data in Gedeo zone, southern Ethiopia: trend, reporting-quality, spatiotemporal distribution, and association with socio-demographic and meteorological variables. *BMC Infect Dis* **21**, 91.
32. Cunningham K, Ploubidis GB, Menon P, *et al.* (2015) Women's empowerment in agriculture and child nutritional status in rural Nepal. *Public Health Nutr* **18**, 3134–3145.
33. Nabiha K, Zunaria A, Farzana K, *et al.* (2017) Maternal malnutrition and its kick on child growth: an alarming trim for Pakistan. *Food Nutr Popul Health* **1**, 1–7.
34. Alkire S, Roche JM, Ballon P, *et al.* (2015) *Multidimensional Poverty Measurement and Analysis*. Oxford: Oxford University Press.
35. Alkire S, Foster JE, Seth S, *et al.* (2015) *Multidimensional Poverty Measurement and Analysis: The Alkire-Foster Counting Methodology*. OPHI Working Paper 86.
36. Weir CB, Jan A (2022) BMI Classification Percentile And Cut Off Points. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing. Available from: http://www.ncbi.nlm.nih.gov/books/NBK541070/
37. Wambogo EA, Ghattas H, Leonard KL, *et al.* (2018) Validity of the food insecurity experience scale for use in Sub-Saharan Africa and characteristics of food-insecure individuals. *Curr Dev Nutr* **2**, nzy062.
38. WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply, Sanitation and Hygiene (2018) JMP methodology: 2017 update & SDG baselines. p. 23, 8 fig., 10 tab.
39. Malapit HJL & Quisumbing AR (2015) What dimensions of women's empowerment in agriculture matter for nutrition in Ghana? *Food Policy* **52**, 54–63.
40. Ersino G, Zello GA, Henry CJ, *et al.* (2018) Gender and household structure factors associated with maternal and child undernutrition in rural communities in Ethiopia. *PLoS One* **13**.
41. EPHI and ICF. *Ethiopia: Mini Demographic and Health Survey 2019; Key Indicators*. Rockville, Maryland, USA: EPHI and ICF. Available at https://www.healthynewbornnetwork.org/resource/ethiopia-mini-demographic-and-health-survey-2019/ (cited 4 June 2020).
42. Tebeje B & Abebe Y (2017) Prevalence and major contributors of child malnutrition in developing countries: systematic review and meta-analysis. *J Child Obes* **2**.

43. Holland C & Rammohan A (2019) Rural women's empowerment and children's food and nutrition security in Bangladesh. *World Dev* **124**, 104648.
44. Shroff M, Griffiths P, Adair L, *et al.* (2009) Maternal autonomy is inversely related to child stunting in Andhra Pradesh, India. *Matern Child Nutr* **5**, 64–74.
45. Kamiya Y, Nomura M, Ogino H, *et al.* (2018) Mothers' autonomy and childhood stunting: evidence from semi-urban communities in Lao PDR. *BMC Womens Health* **18**, 70. doi:10.1186/s12905-018-0567-3.
46. Tiberti M, Zezza A & Azzarri C (2018) *Livestock Ownership and Child Nutrition in Uganda: Evidence from a Panel Survey [Internet]*. AgEcon Search. Available at https://ageconsearch.umn.edu/record/277403 (cited 5 September 2019).
47. Randolph TF, Katjiuongua H, Robinson TP, *et al.* (2015) Livestock and food security: an ILRI perspective. Available at https://cgspace.cgiar.org/handle/10568/65953 (cited 5 September 2019).
48. Murphy SP & Allen LH (2018) Nutritional importance of animal source foods. *J Nutr* **133**, 3932S–3935S.
49. Hetherington JB, Wiethoelter AK, Negin J, *et al.* (2017) Livestock ownership, animal source foods and child nutritional outcomes in seven rural village clusters in Sub-Saharan Africa. *Agric Food Secur* **6**, 1–11.
50. Dror DK & Allen LH (2011) The importance of milk and other animal-source foods for children in low-income countries. *Food Nutr Bull* **32**, 227–243.
51. Neumann CG, Bwibo NO, Gewa CA, *et al.* (2014) Animal source foods as a food-based approach to improve diet and nutrition outcomes. In: Thompson B, Amoroso L, editors. *Improving Diets and Nutrition: Food-Based Approaches*, 1st ed, p. 157–72. UK: CABI. Available from: http://www.cabidigitallibrary.org/doi/10.1079/9781780642994.0157
52. Hulett JL, Weiss RE, Bwibo NO, *et al.* (2014) Animal source foods have a positive impact on the primary school test scores of Kenyan schoolchildren in a cluster-randomised, controlled feeding intervention trial. *Br J Nutr* **111**, 875–886.
53. Leroy JL & Frongillo EA (2007) Can interventions to promote animal production ameliorate undernutrition? *J Nutr* **137**, 2311–2316.
54. Smith J, Sones K, Grace D, *et al.* (2013) Beyond milk, meat, and eggs: role of livestock in food and nutrition security. *Anim Front* **3**, 6–13.
55. Adams F, Ohene-Yankyera K, Aidoo R, *et al.* (2021) Economic benefits of livestock management in Ghana. *Agric Food Econ* **9**, 1–17.
56. Dominguez-Salas P, Kauffmann D, Breyne C, *et al.* (2019) Leveraging human nutrition through livestock interventions: perceptions, knowledge, barriers and opportunities in the Sahel. *Food Secur* **11**, 777–796.