African Journal of Agricultural and Resource Economics Volume 13 Number 1 pages 31-43

Health effects of women's empowerment in agriculture in Northern Ghana: different patterns by body mass index categories

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Abstract

The impact of women's empowerment in agriculture on women\s health, indicated by their body mass index (BMI), is examined using an instrumental variable estimation approach on a sample of 4 267 women. This sample was drawn from both a 2012 and 2015 population-based survey conducted in Northern Ghana. Unlike previous studies, this study accounts for differences in health implications of the different BMI sub-samples (underweight, normal, overweight and obese). The results suggest that women with a high degree of empowerment, regardless of domain (Production, Resources, Income, Leadership *and* Time), *have a significantly higher health status. However, in terms of policy sequencing, it is important to start with enhancing women's empowerment in the* Production *domain. The lack of empowerment in this domain will not only lead to poor health for women, but also have a negative impact on empowerment in the* Income, Resources *and* Leadership *domains that feed back into affecting women's health negatively*.

Key words: agriculture; empowerment; women; BMI; health; Ghana

1. Introduction

Many interventions aimed at improving development indicators (e.g. child and household nutrition, poverty alleviation, education and human capital) consider women's empowerment as a key pathway to making an impact. This is because of the important roles women play in many societies. To demonstrate, estimates from a population-based survey (PBS) (Ghana Statistical Service [GSS] 2012) indicate that Ghanaian women spend about 614%, 94%, 48%, 31% and 7% more time cooking, washing dishes, cleaning, caring for household children and washing clothing respectively, relative to men from the same household. In addition, women also play an important role in Ghana's labour force. When differentiated by industry, women make up approximately 87%, 78% and 75% of the accommodation/food service, manufacturing food products, and wholesale/retail industries respectively (GSS 2012). In the agricultural industries, women make up more than 40% of the labour

force and produce about 70% of the food stock. While men are often responsible for land clearing and preparation, women undertake planting, weeding, post-harvest work and marketing (Amu 2005; Food and Agriculture Organization [FAO] 2011). Thus, women must be adequately empowered and have improved nutritional status to better care for themselves and perform the aforementioned roles. In the available literature on the relationship between women's empowerment and women's health and nutritional status, the Body Mass Index (BMI) is used as an indicator of women's health (Sraboni *et al*. 2014; Malapit & Quisumbing 2015; Ross *et al*. 2015). BMI is calculated as the ratio of an individual's weight (kg) to their height squared (m^2). In adults, BMI is used to identify underweight (BMI < 18.5 kg/m^2), normal (18.5 kg/m^2 < BMI ≤ 24.9 kg/m^2), overweight (25.0 kg/m^2 ≤ BMI ≤ 29.9 kg/m^2) and obese (BMI ≥ 30.0 kg/m^2) individuals (World Health Organization [WHO] 2011). The BMI is used as an indicator of an individual's health status because it is strongly correlated with various metabolic and disease outcomes (Garrow & Webster 1985; Freedman *et al*. 2013; Wohlfahrt-Veje *et al*. 2014). Also, a negative association between health-related quality of life (HRQoL) and BMI has been observed in adults (Kortt & Clarke 2005; Lee *et al*. 2005; De Beer *et al*. 2007).

The majority of the literature has used indicators that focus on women's household decision-making or their reproductive roles to measure women's empowerment (Thomas, 1994; Smith *et al*. 2003; Bhagowalia *et al*. 2012), while some has used indicators that focus on women's empowerment in production. For those works focusing on women's empowerment in production, only a handful have indicators that measure women's empowerment in agricultural production, which has been possible since the development of the Women's Empowerment in Agriculture Index (WEAI) (Alkire *et al*. 2013).

The WEAI was developed to facilitate the monitoring, evaluation and diagnosis of women's empowerment and agency, and their inclusion in agriculture. Applied in multiple countries, WEAI showed in 2012 that the main causes of disempowerment in agriculture are (i) a lack of access to credit and a lack of power to make credit-related decisions, (ii) low prevalence of group membership, and (iii) excessive workload. The WEAI and its component indicators have been shown to also have a positive multiplier effect on household food security status and child nutrition (Sraboni *et al*. 2014; Cunningham *et al*. 2015a, 2015b; Malapit & Quisumbing 2015; Malapit *et al*. 2015a, 2015b; Ross *et al*. 2015). However, using pooled BMI data for women in Northern Ghana, both Malapit and Quisumbing (2015) and Ross *et al*. (2015) failed to find a significant association of overall agricultural empowerment with women's health measured using their BMI scores. Using ordinary least squares (OLS) regression, Malapit and Quisumbing (2015) showed that women's overall agricultural empowerment and their empowerment relative to men within the same households were not significantly associated with women's BMI. Using a multiple indicators multiple causes model to account for endogeneity of empowerment, Ross *et al*. (2015) also did not find a significant relationship between overall agricultural empowerment and women's BMI scores. When the individual indicators of agricultural empowerment were used, Ross *et al*. (2015) showed that adequacy in access to and decisions on credit, ownership of assets, autonomy in production, group membership and leisure time were positively and significantly associated with women's BMI.

Unlike previous studies, this study analyses women's health by categorising women into underweight, normal, overweight and obese categories based on their BMI scores, and separately investigates the effect of empowerment on their health status. In addition, this study uses standardised indices of the five domains – *Production*, *Resources*, *Income*, *Leadership* and *Time* – of the WEAI, as well as an aggregate indicator to assess women's empowerment. In doing so, the study's objective is to examine the relative impact of women's empowerment across the five domains on women with a BMI classified as underweight, normal, overweight or obese. Following Sraboni *et al*. (2014), this study uses instrumental variable estimation (IVR) to account for the endogeneity of empowerment to consistently estimate the parameters of interest. Unlike previous studies, this study uses samples of women drawn from two rounds (2012 and 2015) of a PBS of farm households in Northern Ghana.

2. The Women's Empowerment in Agriculture Index

According to Alkire *et al*. (2013), existing measurements of empowerment, which are usually aggregated at the country level, cannot be decomposed into indicators for subpopulations by age groups, regions, etc. Such existing indices include (1) those developed by the United Nations Development Program (UNDP): the Gender Inequality Index, the Gender Empowerment Measure, the Inequality-adjusted Index, and the Multidimensional Poverty Index (United Nations Development Program [UNDP] 2010), (2) the Organization for Economic Co-operation and Development's (OECD) Social Institutions and Gender Index ([OECD] 2015), and (3) the Gender Gap Index developed by Hausmann *et al*. (2011). In addition, many cannot capture resource control or agency within the agricultural sector (Alkire *et al*., 2013). The WEAI, in contrast, uses individual-level data of men and women within the same household. As such, the WEAI aggregates the overlapping achievements in different domains in a multidimensional empowerment profile for each man and woman within the same household into a country index, which can further be decomposed into indices for the sub-population of a country.

The WEAI is constructed from two weighted sub-indices: an index for the five domains of empowerment (5DE), with a weight of 0.9, and a gender parity index (GPI), with a weight of 0.1. Both the 5DE and GPI range from zero to one, with higher values indicating a greater level of empowerment. According to Alkire *et al*. (2013), the 5DE Index is the sum of the achievement in 10 indicators grouped into five domains (*Production*, *Resources*, *Income*, *Leadership* and *Time*) (see Table 1), and it can be constructed for everyone in the sample as an adequacy score.

Table 1: Components of the Five Domains of Empowerment Index (5DE) and weights

Domain	Indicator	Weight
Production	Input in productive decisions	1/10
	Autonomy in production***	1/10
Resources	Ownership of assets	1/15
	Purchase, sale or transfer of assets	1/15
	Access to and decisions on credit	1/15
Income	Control over use of income	1/05
Leadership	Group member	1/10
	Speaking in public	1/10
Time	Workload	1/10
	Leisure	1/10

Source: Alkire *et al*. (2013)

The five domains of empowerment are defined by Alkire *et al*. (2013) as follows:

(i) *Production* – sole or joint decision making over food and cash-crop farming, livestock and fisheries, as well as autonomy in agricultural production.
(ii) *Resources* – ownership, access to and power in making decisions over productive resources (land, agricultural equipment, livestock, credit and consumer durables).
(iii) *Income* – sole or joint control over the use of income.
(iv) *Leadership* – community leadership, measured by membership in economic or social groups and comfort in speaking in public.
(v) *Time* – time allocated to productive and domestic tasks and satisfaction with leisure time.

The weights for all indicators in any given domain sum to 0.2; that is, all domains are weighted equally. Based on the 5DE, an empowered individual is one who has achieved adequacy in 80% or more of the weighted indicators.

The GPI component captures the primary/secondary female decision maker's (hereafter "key woman") achievements in the 5DE relative to that of the primary/secondary male decision maker (hereafter "key man") in the same household. Households are classified as having gender parity if the key woman is empowered (5DE ≥ 0.8) or if her adequacy score is greater than or equal to that of the key man in her household, even if she is not empowered (5DE < 0.8).

In the context of this study, six main women's empowerment measures based on the WEAI and its constituent domains are utilised. Five are constructed as the adequate achievement of the key woman in the d^{th} domain, as

$$D_{di} = \left(\sum_{dj} w_{dj} I_{dji}\right)/0.2, \qquad (d = 1, \ldots, 5), \tag{1}$$

where I_{ji} takes on the value of one if the i^{th} key woman has adequate achievement in j^{th} indicator for domain d, and zero otherwise, and w_j is the weight for the j^{th} indicator, such that $\sum_j w_j = 1$ (see Table 1 for the indicator weights). The sixth measure (C_{0i}) – the achievement of the key woman in the *Aggregate* agricultural empowerment – is computed as

$$C_{0i} = \frac{1}{5}\sum_{d}^{5} D_{di}. \tag{2}$$

We divide the value by five to standardise $\boldsymbol{C_{0i}}$ to take on a value between zero and one. With these transformations, this study identifies a woman as empowered if her i^{th} empowerment indicator's value is greater than or equal to 0.8.

3. Material and methods

3.1 Data and descriptive analysis

The sample was drawn from a PBS conducted in four regions in Northern Ghana – Upper West, Upper East, Brong Ahafo and Northern regions – in 2012 and 2015 (see Figure 1 for study area). These areas are designated as a United States Agency for International Development (USAID) Feed the Future (FTF) Zone of Influence (ZOI). The sampling for the baseline (2012) survey followed a two-stage stratified design according to which 20 households were drawn from the 230 enumeration areas in the ZOI (see Zereyesus *et al*. 2014). Thus, 4 410 households from the baseline survey in 2012 and 4 293 households from the follow-up survey in 2015 were interviewed. Survey responses from a sample of 2 228 households in 2012 and 2 039 households in 2015 were used for the study, for which each household had an estimated empowerment index and BMI for the key woman. Selected summary statistics are presented in Table 2.

Across the two surveys, 6% of the households were female headed, with an average of about five members in adult equivalents (AE) and a dependency ratio of 0.51. Household size in terms of adult equivalence (AE) is computed by dividing the total energy requirements of the household by 2 900 kcal, which is the energy requirement of an adult male between the ages of 19 and 50 years (National Academy of Sciences – National Research Council 1989). Men were generally older and more educated than women. About 11% of women were pregnant at the time of the survey. In addition, the rate of participation in off-farm work by the women was 72%, which had increased from 2012 to 2015. The dietary diversity score and number of groups for women were estimated at four and one respectively. Average wealth index was estimated at -0.38; however, this had deteriorated from 2012 to 2015. In addition, only 7% of households had a fridge, and only 23% of the women solely or jointly owned a mobile phone. However, mobile phone ownership by women had improved from 2012 to 2015.

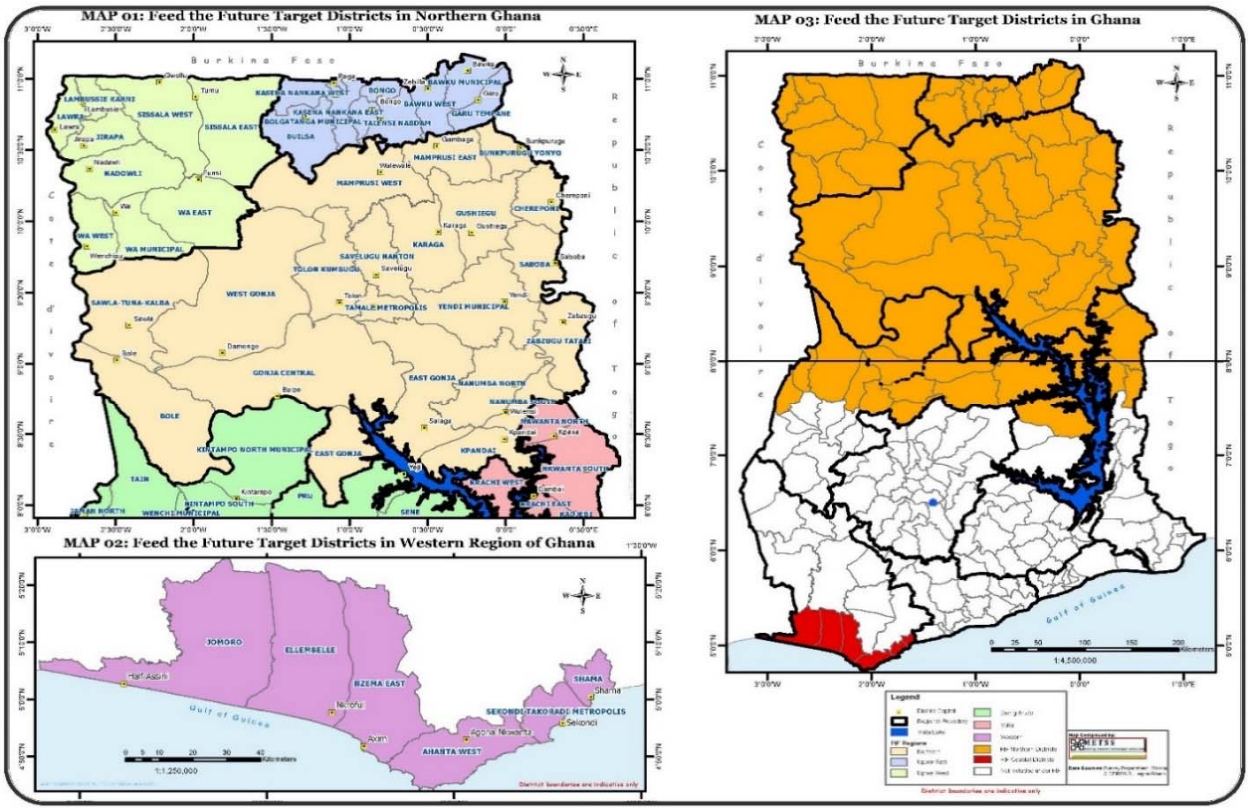

Figure 1: Feed the Future (FTF) Zone of Influence (ZOI)
Source: Zereyesus *et al*. (2014)

The WEAI and its related indices were calculated using a procedure similar to that of Vaz and Alkire (2012a, 2012b). The results show that only 14.6% of the women across the two surveys were empowered. However, the percentage of empowered women had declined from 15.4% in 2012 to 13.6% in 2015. Despite the low instances of empowerment, those who were disempowered experienced adequate achievement in about 58.6% of the 5DE Index domains. In terms of the five domains, 55.1%, 91.0%, 71.2%, 73.5% and 74.8% of the key women in the sample had adequate achievement in the *Resources*, *Time*, *Production*, *Income* and *Leadership* domains respectively.

The data furthermore show that women perform more poorly than men across all indicators and are three times as disempowered as men. Overall, 66.7% of the women had no gender parity and their average empowerment gap was 26.0%. The average individual overall empowerment for women (men) in 2012 was 0.58 (0.78), and this decreased by 4.0% (7.6%) to 0.56 (0.72) in 2015.

Table 2: Summary statistics of selected household characteristics

Year	2012		2015		Pooled [n = 4 267]
Empowerment of key woman	**Empowered [n = 1 884]**	**Disempowered [n = 344]**	**Empowered [n = 1 762]**	**Disempowered [n = 277]**	
Key woman characteristics					
Female household head (yes = 1)	0.07 ^{B} (0.26)	0.09 ^{B} (0.29)	0.03 ^{A} (0.17)	0.05 ^{AB} (0.23)	0.06 (0.23)
Age (year)	31.36 (7.84)	34.19 ^{A} (7.51)	33.55 ^{A} (7.58)	34.26 ^{A} (7.43)	32.68 (7.77)
Education (year)	1.06 ^{A} (3.76)	1.02 ^{A} (3.54)	1.07 ^{A} (3.73)	1.21 ^{A} (3.89)	1.07 (3.74)
Woman married	0.99 ^{A} (0.09)	1.00 ^{A} (0.05)	0.97 (0.16)	0.94 (0.24)	0.98 (0.14)
Pregnant (yes = 1)	0.12 ^{A} (0.32)	0.08 ^{A} (0.27)	0.10 ^{A} (0.30)	0.08 ^{A} (0.27)	0.10 (0.30)
Child care (yes = 1)	0.31 ^{A} (0.46)	0.31 ^{A} (0.46)	0.30 ^{A} (0.46)	0.31 ^{A} (0.46)	0.31 (0.46)
Off-farm work (yes = 1)	0.68 ^{A} (0.46)	0.72 ^{AB} (0.45)	0.77 ^{B} (0.42)	0.73 ^{AB} (0.45)	0.72 (0.45)
Dietary diversity score	4.52 (1.62)	4.92 (1.47)	3.85 ^{A} (1.55)	3.98 ^{A} (1.49)	4.24 (1.62)
No. of groups (count)	0.59 (0.74)	1.42 ^{A} (0.78)	0.67 (0.80)	1.29 ^{A} (0.72)	0.74 (0.81)
Phone ownership (yes = 1)	0.20 ^{A} (0.40)	0.33 B (0.47)	0.22 ^{A} (0.41)	0.32 ^{B} (0.47)	0.23 (0.42)
Key man characteristics					
Age (year)	39.97 (12.31)	42.72 ^{A} (12.06)	41.82 ^{A} (11.93)	42.35 ^{A} (12.38)	41.11 (12.18)
Education (year)	2.69 ^{A} (5.82)	2.66 ^{A} (5.61)	2.57 ^{A} (5.66)	2.40 ^{A} (5.49)	2.62 (5.72)
Phone ownership (yes = 1)	0.55 ^{A} (0.50)	0.55 ^{A} (0.50)	0.40 (0.49)	0.30 (0.46)	0.47 (0.50)
Household characteristics					
Size (AE)	4.77 ^{A} (2.38)	4.99 ^{A} (2.05)	4.89 ^{A} (2.18)	5.14 ^{A} (1.99)	4.86 (2.25)
Dependency (ratio)	0.51 ^{A} (0.03)	0.51 ^{AB} (0.03)	0.51 ^{B} (0.03)	0.51 ^{AB} (0.02)	0.51 (0.03)
Wealth (index)	-0.84 ^{A} (1.48)	-0.80 ^{A} (1.30)	0.14 ^{B} (1.17)	-0.07 ^{B} (1.02)	-0.38 (1.40)
Farm size (ha)	2.39 ^{B} (3.93)	2.63 ^{B} (6.16)	1.52 ^{A} (2.00)	1.45 ^{A} (1.46)	1.99 (3.44)
Own motorbike (yes = 1)	0.03 ^{A} (0.16)	0.07 (0.26)	0.03 ^{A} (0.17)	0.02 ^{A} (0.15)	0.03 (0.17)
Own bicycle (yes = 1)	0.76 ^{B} (0.42)	0.80 ^{B} (0.40)	0.69 ^{A} (0.46)	0.74 ^{AB} (0.44)	0.74 (0.44)
Own TV (yes = 1)	0.20 ^{A} (0.40)	0.20 ^{A} (0.40)	0.27 ^{B} (0.44)	0.22 ^{AB} (0.41)	0.23 (0.42)
Own radio (yes = 1)	0.60 ^{A} (0.49)	0.66 ^{A} (0.48)	0.52 (0.50)	0.61 ^{A} (0.49)	0.57 (0.49)
Refrigerator (yes = 1)	0.06 ^{A} (0.24)	0.06 ^{A} (0.23)	0.08 ^{A} (0.28)	0.05 ^{A} (0.23)	0.07 (0.25)
Location characteristics					
Informal credit	0.01 ^{AB} (0.08)	0.03 ^{C} (0.18)	0.00 ^{A} (0.06)	0.02 ^{BC} (0.15)	0.01 (0.09)
Institutional credit	0.02 ^{A} (0.14)	0.06 (0.23)	0.01 ^{A} (0.10)	0.02 ^{A} (0.15)	0.02 (0.13)
Group-based credit	0.02 ^{A} (0.15)	0.18 (0.38)	0.02 ^{A} (0.15)	0.08 (0.28)	0.04 (0.19)
Urban (yes =1)	0.23 ^{B} (0.42)	0.20 ^{AB} (0.40)	0.22 ^{B} (0.41)	0.13 ^{A} (0.34)	0.22 (0.41)
Distance to health facility (km)	16.55 ^{A} (8.46)	14.31 (8.26)	16.63 ^{A} (8.64)	16.99 ^{A} (7.54)	16.43 (8.48)
Female JHS/SHS graduate rate	0.36 ^{A} (0.13)	0.41 (0.10)	0.36 ^{A} (0.13)	0.36 ^{A} (0.13)	0.37 (0.13)

Parentheses denote standard deviations

Values in the same row indicated by the same superscript letters (A and/or B) are not statistically different from one another at the 5% significance level. Comparisons are done with Bonferroni adjustments.

A paired t-test mean comparison also shows that women's empowerment, at 31.5%, is significantly ($p = 0.01$) lower than that of men. The WEAI for the sample is estimated at approximately 0.677; however, this declined by 0.6% between 2012 and 2015. Despite the decline in the WEAI, the GPI improved by 1.5% from 2012 and 2015. Thus, the decline in the WEAI is driven by a decline in the 5DE Index, which had deteriorated by about 1% since 2012.

The distribution of women by the four BMI categories and by empowerment status indicates that there are more disempowered women relative to empowered women in the underweight and obese categories across the two surveys (Figure 2). There thus are totals of 239 and 308 women in the disempowered category against 53 and 52 women in the empowered category in 2012 and 2015 respectively. The underweight and obese categories pose the most serious problem – particularly in developing countries, where a woman's well-being is directly link to that of her children and the household as whole.

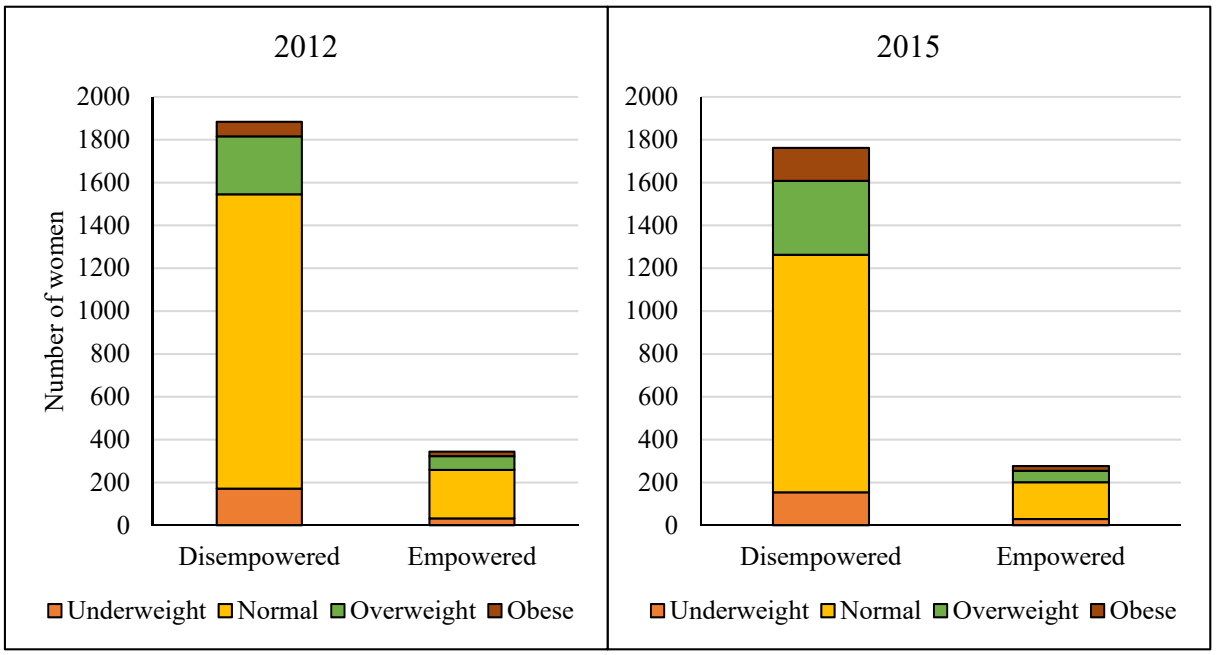

Figure 2: Distribution of women by BMI categories and year
Source: Authors' calculations from PBS Ghana 2012 and 2015

3.2 Econometric model specifications

Previous studies that examined the relationship between empowerment and women's health have shown that the relationship is likely endogenous. Thus, for a given woman, both her empowerment and health status are likely to be affected by the same factors. To overcome this, the study applies the IVR approach (Sraboni *et al*. 2014; Tsiboe *et al*. 2017). The model is specified as

$$E_{hd} = \gamma_0 + \gamma_1 \boldsymbol{I}_h + \varepsilon_\gamma \,, \tag{3}$$

$$\ln F_{hj} = \beta_0 + \beta_1 E_{hd} + \beta_2 \boldsymbol{W}_h + \beta_3 \boldsymbol{D}_h + \beta_4 \boldsymbol{L}_h + \varepsilon_\beta \,, \tag{4}$$

where the variable E_{hd} denotes the d^{th} measure of disempowerment (inadequacy in the five domains (D_{id}) and its aggregation (C_{0i}) for the key woman in household h. The vector $\boldsymbol{I}_h$ contains variables used as instruments for disempowerment. Following Sraboni *et al*. (2014) and Ross *et al*. (2015), the vector $\boldsymbol{I}_h$ contains variables used as instruments for empowerment. These include age and educational differences between the key woman and man in household h, types and combinations of credit sources available in the village, mobile phone ownership by households, farm size, household information channels (radio only, TV only, or both), household transportation assets (bicycle only, motorbike only, or both), district-level female junior high school/senior high school (JHS/SHS) graduate rate, and ethnicity.

Age and educational differences reflect human capital differences and relative bargaining strengths between the key woman and key man (Quisumbing & Hallman 2003). Sraboni *et al*. (2014) note that many informal credit sources could be indicative of the size of the informal community credit market, facilitating credit-related decision making and the accumulation of assets. Mobile phone ownership reflects the utilisation of technologies to facilitate empowerment. More so, who actually owns mobile phones in a given household could have implications for empowerment (Buskens & Webb 2009). Ethnicity captures differences in culture that may also affect empowerment. For instance, sole ownership is typically indicative of empowerment; however, qualitative work done by Doss *et al*.

(2014) in Uganda has shown that women are more empowered if they jointly own valuable assets than if they solely own minor assets.

The variable F_{hj} in equation (4) denotes the key woman's health in household h measured by her BMI. Note that, in addition to empowerment, a woman's BMI can be the result of many other factors, such as nutrition, household wealth, cultural factors, etc. As such, the study includes the vectors $\boldsymbol{W}$, $\boldsymbol{D}$ and $\boldsymbol{L}$, representing the key woman, household and location characteristics respectively. A woman's characteristics include her position within the household, her age, education, pregnancy and childcare status, participation in off-farm work, dietary diversity score, and number of groups. Household characteristics include dependency ratio, wealth and food storage (having a fridge). The vector $\boldsymbol{L}$ represents location variables, including district mean distance to health facility, region fixed effects (four districts), ethnicity, locality (urban or rural), and a year fixed effect (2012 and 2015). Finally, the error terms ε_{β} and ε_{δ} are error terms assumed to be normally distributed with mean zero.

Since the outcome variable is in logs, the estimated coefficients are interpreted as the percentage change in outcome for a one-unit change in empowerment. However, because of the standardisation of all empowerment indicators, one unit here means 100%. Thus, for the same outcome, the responsiveness to the empowerment domains can be compared to provide a sense of which domains matter when a policy is aimed at improving the given outcome.

4. Econometric model results

Estimations of equations (3) and (4) were done separately for each of the four BMI categories over the six empowerment indicators (24 separate models).[1] Similar to Tsiboe *et al*. (2017), the outcome of the endogeneity test is different for the different combinations of the four BMI categories and empowerment indicators. The Anderson-Rubin test statistics imply that the empowerment indicators are relevant. Thus both the endogeneity and Anderson-Rubin test statistics suggest that the empowerment indicators are endogenous. However, where the evidence against endogeneity is very weak ($p < 0.50$), the models in question are estimated using ordinary least squares (OLS). Thus, a total of eight IVR and 16 OLS models are estimated. The Kleibergen-Paap test statistic suggests that, at $p < 0.10$, the IVR first-stage regressions are not under-identified, although over-identification is not rejected. Regarding weak instruments, about 17% of the Cragg-Donald Wald F test statistics for the IVR models fail to exceed the critical value of 4.59. Thus, these models have a bias of less than 30% relative to OLS (Stock & Yogo 2005), indicating that the instruments used may be weak. Finally, for IVR models in which endogeneity is weakly rejected, the coefficient estimated by their counterpart OLS models is presented and interpreted instead of the IVR coefficients.

4.1 Effect of empowerment on women's health

The marginal effects of all empowerment indicators by BMI category are presented in Table 3. The most striking result is in the category of women classified as obese, for which all the significant ($p < 0.05$) empowerment indicators (*Aggregate*, *Production* and *Income*) are negatively associated with their BMI. The negative sign implies that, as the obese key woman's empowerment increases, the lower her BMI will be. For these women, who are already facing health risk factors – e.g. diabetes, hypertension and low HRQoL (Garrow & Webster 1985; Kortt & Clarke 2005; Lee *et al*. 2005; De Beer *et al*. 2007; Freedman *et al*. 2013; Wohlfahrt-Veje *et al*. 2014) – a decrease in their BMI is indicative of an improvement in health.

[1] Complete regression results, as well as the STATA codes, can be obtained from the corresponding author upon request.

Table 3: Responsiveness of women's health to empowerment in agriculture indicators

Empowerment indicator	Underweight (n = 386)	Normal (n = 2 877)	Overweight (n = 732)	Obese (n = 264)	Average effect [a]
Aggregate	0.072 (0.133)	0.001 (0.009) OLS	0.001 (0.011) OLS	-0.257** (0.117) OLS	0.046 [0.145]
Resources	0.707** (0.341)	0.014 (0.028) OLS	0.048 (0.084)	-0.347 (0.527) OLS	-0.074 [0.447]
Time	0.883 (0.653)	0.019 (0.028) OLS	0.033 (0.035) OLS	-0.285 (0.428) OLS	-0.137 [0.513]
Production	-0.134 (0.208) OLS	-0.108 (0.217)	-0.057 (0.133)	-1.040*** (0.368) OLS	0.252 [0.535]
Income	0.161 (0.585)	-0.007 (0.020) OLS	-0.011 (0.024) OLS	-0.891** (0.404) OLS	0.178 [0.481]
Leadership	-0.621** (0.280) OLS	0.067 (0.267)	0.004 (0.034) OLS	0.040 (0.456) OLS	0.163 [0.309]

Significance levels: * $p < 0.1$ ** $p < 0.05$, *** $p < 0.10$.
Standard errors adjusted for robustness against heteroscedasticity are in parenthesis.
[a] Calculated as the arithmetic average across the estimated parameters over the BMI categories; the standard deviations are in brackets.

The estimates of the responsiveness of women's health to aggregate agriculture empowerment shown above indicate that there is a corresponding reduction of 0.257% in the BMI of obese women if their empowerment in agriculture increases by 1%. When disaggregated, increasing adequate achievement in the *Production* domain has the highest beneficial effect on the health of obese women, with an elasticity of 1.040%, followed by the *Income* (0.891%), *Resources* (0.347 %) and *Time* (0.285%) domains.

In contrast to the obese woman, an increase in the BMI of the underweight woman is considered an indication of an improvement in health. Underweight women are more likely to experience fragile bones, a weakened immune system and tiredness. With that in mind, women classified as underweight have the *Resources* empowerment indicator significantly and positively associated with their BMI ($p < 0.05$). However, when empowerment is disaggregated by *Leadership*, the BMI of the underweight woman declines significantly – by 0.621% for a 1% increase in her adequacy.

The results presented above suggest that an empowered woman will have an improved health status, with varying effects of each of the individual empowerment indicators. By averaging the estimated responsiveness of women's health to empowerment across the BMI categories, we can rank which domains of empowerment are important in terms of policy sequencing. Note that, for the obese group, a negative estimated responsiveness is an improvement in health. As such, before averaging, their estimated responsiveness is multiplied by negative one.

Relatively speaking, the *Production* domain has the highest positive effects on women's health, followed by the *Income*, *Leadership*, *Resources* and *Time* domains. The effect of *Production* empowerment may lead to good production decisions. Consequently, good production decisions may contribute to further empowerment in the *Income* domain. This ultimately affects how people make food choices (leading to the consumption of healthy food), and results in a reduction in obesity and an improvement in the BMI of underweight women. So, addressing the lack of empowerment in the *Production* domain, particularly, can help slow the continued downward spiral.

In Ghana, foodstuffs such as grains and roots/tubers are the cheapest sources of dietary energy (Ministry of Food and Agriculture [MOFA] 2013). In contrast, the more nutrient-dense foodstuffs, such as legumes, fruit and vegetables, generally cost more. According to Drewnowski and Darmon (2005), the negative relationship between the caloric density of foods (kcal/kg) and their caloric cost means that more caloric-dense diets are associated with an effective way to save money. Thus, a woman with inadequate achievement in the *Production* and/or *Income* domain is likely to shift from

consuming less expensive and less nutritious foods to more expensive and more nutritious foodstuffs. The link between adequacy in the *Production* domain and health is not only experienced through its potential effect on income, which ultimately affects how people make food choices, but also in the level of physical activity of the individual. Thus, women engaged in production are physically active and are less likely to be overweight or obese.

4.2 Effect of control variables on women's health

Table 4 shows the marginal effects of control variables on women's health. The estimates show that, as the dietary diversity of the woman increases, so does her BMI. Higher household wealth results in increased BMI scores, which are consistent with the expected positive effect of household income on women's health, regardless of their BMI category. Educated key women have a relatively higher health status than uneducated women. In contrast, a pregnant key woman has a relatively better health status than a key woman who is not pregnant. This is likely due to the antenatal care given to pregnant women (Harrison 1985; McDonagh 1996; Massawe *et al*. 1999; Carroli *et al*. 2001; Mrisho *et al*. 2009).

Table 4: Marginal effects of control variables on women's health

Variable	Underweight (n = 386)		Normal (n = 2 877)		Overweight (n = 732)		Obese (n = 264)	
	IV	OLS	IV	OLS	IV	OLS	IV	OLS
Key woman characteristics								
Head (yes = 1)	0.108* (0.061)	0.101* (0.056)	0.012 (0.007)	0.011 (0.007)	-0.010 (0.008)	-0.010 (0.008)	-0.123 (0.076)	-0.119 (0.073)
Age (ln[years])	-0.066 (0.052)	-0.047 (0.046)	0.008 (0.008)	0.009 (0.007)	0.012 (0.010)	0.012 (0.010)	0.083 (0.163)	0.074 (0.159)
Educated (yes = 1)	-0.147 (0.141)	-0.146 (0.141)	0.019** (0.008)	0.019** (0.008)	0.023*** (0.007)	0.023*** (0.007)	0.122 (0.132)	0.128 (0.134)
Pregnant (yes = 1)	-0.089 (0.101)	-0.087 (0.101)	0.024*** (0.006)	0.024*** (0.006)	-0.006 (0.006)	-0.006 (0.006)	-0.134** (0.066)	-0.148** (0.063)
Child care (yes = 1)	0.006 (0.040)	0.003 (0.040)	-0.005 (0.004)	-0.004 (0.004)	0.003 (0.005)	0.003 (0.005)	-0.044 (0.062)	-0.045 (0.062)
Off-farm work (yes = 1)	-0.024 (0.021)	-0.027 (0.022)	0.008* (0.004)	0.007* (0.004)	-0.001 (0.005)	-0.001 (0.005)	0.096* (0.055)	0.093* (0.054)
Dietary diversity score	0.048*** (0.016)	0.051*** (0.016)	-0.001 (0.001)	-0.001 (0.001)	0.000 (0.001)	0.000 (0.001)	0.010 (0.026)	0.009 (0.027)
No. of groups (count)	-0.013 (0.023)	0.001 (0.018)	-0.006 (0.005)	-0.004 (0.003)	0.005 (0.004)	0.005 (0.003)	-0.001 (0.055)	0.018 (0.038)
Household characteristics								
Dependency (ratio)	-0.364 (0.432)	-0.456 (0.420)	-0.024 (0.064)	-0.031 (0.063)	0.048 (0.065)	0.046 (0.064)	-0.386 (1.272)	-0.342 (1.255)
Wealth (index)	0.021** (0.011)	0.017* (0.010)	-0.001 (0.002)	-0.001 (0.002)	0.003 (0.002)	0.003 (0.002)	-0.002 (0.033)	-0.004 (0.032)
Refrigerator (yes = 1)	0.014 (0.221)	0.012 (0.220)	0.015* (0.009)	0.015* (0.009)	0.008 (0.007)	0.008 (0.007)	-0.057 (0.104)	-0.063 (0.104)
Health facility distance (ln[km])	0.070* (0.038)	0.067* (0.037)	0.003 (0.004)	0.003 (0.004)	-0.004 (0.005)	-0.004 (0.005)	0.065 (0.070)	0.061 (0.073)
Urban (yes = 1)	-0.204** (0.103)	-0.194* (0.101)	0.021*** (0.005)	0.021*** (0.005)	0.000 (0.007)	0.000 (0.007)	-0.120 (0.100)	-0.109 (0.093)
Year (base = 2012)	-0.061* (0.035)	-0.058* (0.033)	0.001 (0.004)	0.000 (0.004)	0.003 (0.005)	0.003 (0.005)	0.151** (0.068)	0.144** (0.068)
Constant	2.987*** (0.372)	3.079*** (0.366)	3.029*** (0.045)	3.038*** (0.042)	3.229*** (0.050)	3.229*** (0.050)	3.339*** (0.789)	3.428*** (0.746)
R-squared (%)	8.69	9.36	4.38	4.58	7.61	7.63	11.43	11.79
F statistic	1.262*	1.344*	4.553***	4.564***	2.113***	2.135***	1.032*	1.109*

Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.10$

Key women in households in urban areas are healthier than those living in rural areas. While Benkeser *et al*. (2012) suggest that urban dwelling is associated with obesity in Ghana, Sraboni *et al*. (2014) find that household wealth, education and occupation are more important determinants of adult BMI in Bangladesh.

5. Summary and conclusions

In addition to being the major suppliers of productive agricultural labour, women assume responsibility for housekeeping, meal preparation and child/elder care. As a result, many interventions aimed at improving development indicators consider women's empowerment as a key pathway to make an impact. This study examined health effects – as measured by their BMI – of women's empowerment in agriculture in Northern Ghana. In addition, this study allowed for the responsiveness of women's BMI scores to empowerment/adequacy indicators to vary by women falling into underweight, normal, overweight and obese categories. Following the literature, the study applied an IVR estimation approach to an aggregate sample of 4 267 women drawn from two population-based surveys (2012 and 2015) conducted in four regions in Northern Ghana to consistently estimate the effect of women's empowerment on their health.

The findings of this study can help guide policy interventions aimed at improving women's status and reducing gender disparity. By decomposing the WEAI into its component domains, this study has identified that, in terms of policy sequencing to improve the health of women, it is important to start with enhancing women's empowerment in the *Production* domain, because a lack of empowerment in this domain will not lead only to the poor health of women, but also have a negative impact on empowerment in the *Income*, *Resources* and *Leadership* domains that feed back into affecting women's health negatively.

Acknowledgements

The authors acknowledge funding support from the USAID-Ghana Mission Economic Growth Office through USAID Grant Number: BG3824 and project number GAGE603117. However, this paper does not reflect the views of the USAID and its programmes. All errors and omissions are the responsibility of the authors.

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