Policy Research Working Paper 10560

Women's Empowerment and Child Nutritional Outcomes in Rural Burkina Faso

Pouirkèta Rita Nikiema
Monsoi Kenneth Colombiano Kponou

WORLD BANK GROUP
Africa Region
Office of the Chief Economist
September 2023

Policy Research Working Paper 10560

Abstract

Across developing countries, women play an important role both as producers of major food crops and in improving household nutrition. This research paper aims to assess the effect of improving women's empowerment on the nutritional status of children in rural Burkina Faso. Based on data from the 2014 Multisectoral Continuous Survey, the paper uses variables such as income control, access to land, autonomy in production decisions, access to credit, and social group membership to compute a composite index of women's empowerment. Accounting for potential endogeneity of empowerment, the study adopts a dual-estimation approach that, first, uses average empowerment by stratum and, second, applies an instrumental variable. The results show a low baseline level of women's empowerment in rural areas, but an improvement in empowerment has a relatively high and positive correlation with children's nutritional outcomes. The study suggests that improving women's empowerment components will translate into significant gains in children's nutritional outcomes in rural households.

This paper is a product of the Office of the Chief Economist, Africa Region. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The authors may be contacted at pnikiema@worldbank.org and ritanikiema@yahoo.fr.

Women's Empowerment and Child Nutritional Outcomes in Rural Burkina Faso

****

AERC-World Bank Visiting Scholarship Paper

Pouirkèta Rita NIKIEMA
Université Norbert Zongo
AERC-World Bank Visiting Scholars Program
ritanikiema@yahoo.fr

Monsoi Kenneth Colombiano KPONOU
Université Abomey-Calavi
xcolombiano@yahoo.fr

Keywords: Women, Empowerment, Agriculture, Children's Nutrition, Burkina Faso

JEL Classification: C26; D13; D16; I12, Q12

Acknowledgments: We thank Kathleen Beegle, Moussa Blimpo, Markus Goldstein, Aparajita Goyal, the participants of the World Bank Visiting Scholars seminars, and the participants of the AERC-BMGF November 2017, June and November 2018 workshops, for helpful comments and suggestions. We are grateful to the 2020 AERC-World Bank Visiting Scholars program for all support. Financial support from African Economic Research Consortium (AERC), through grant No. RT17537, is also gratefully acknowledged. All remaining errors are our own. The views expressed in this paper are entirely ours, and do not necessarily represent those of the World Bank or its Board of Directors.

1. Introduction

Policies aimed at improving women's status and reducing inequalities are expected to improve not only women's well-being, but also that of their children. Since women are typically responsible for childcare, they have a greater responsibility for and role in their nutritional status (Malapit and Quisumbing, 2014, Bhagowalia et al., 2012; Smith et al., 2003). Women account for 43% of the agricultural labor force in developing countries (FAO, 2011). However, studies have shown that women own only about 2% of the world's land, or 15% of the land in Sub-Saharan Africa (Doss et al., 2013). These figures show that women still have unequal access to land compared to men. This is an impediment especially in areas where agriculture is the main activity.

Meanwhile, over the last five decades, the Women, Business and the Law report indicates that globally there has been progress toward gender equality in the law in terms of ownership and inheritance rights to property. Indeed, worldwide women enjoy 77% of the legal rights that men have (World Bank, 2023). Besides, realizing gender equality and the empowerment of women and girls will make a crucial contribution to progress and achievement in the 5th of the Sustainable Development Goals (United Nations General Assembly, 2015).

In the meantime, child malnutrition is prevalent around the world and in many forms. According to Herforth et al., (2012), the burden of malnutrition is threefold: the lack of energy and protein in the diet, micronutrient deficiency, and energy excess in diets. Malnutrition is estimated to be responsible for over a fifth of the global disease burden in children under five years of age (Bhutta et al., 2010; Black et al., 2008) and for 45% of the 5.9 million deaths in children under five in 2015 (WHO, 2016).[1] Also, malnutrition can harm a child's economic prospects and, as a consequence, broader socioeconomic development in numerous ways (UNICEF, 2019).

[1] In Belesova et al. (2017).

Some studies have shown that an improvement in the decision-making power of women is accompanied by more favorable allocation of household resources to the benefit of children (Smith et al., 2003; Seebens, 2011; Bhagowalia et al., 2012; Nordman & Sharma, 2016). Thus, empowerment of women in agricultural activities can therefore be used as a catalyst in the reduction of child malnutrition. Indeed, women's empowerment is considered crucial for improving nutritional outcomes (Christian et al., 2023; Sey-Sawo et al., 2023; Hastuti et al., 2022; Onah, 2021; Melesse, 2021; Malapit and Quisumbing, 2015; Malapit et al., 2015a; Van den Bold et al., 2013; Bhagowalia et al., 2012).

Melesse (2021) found in Ethiopia that empowering women in household agricultural decisions and increasing their access to and control of economic resources are more promising for improving child nutrition . Christian et al. (2023) suggest that an increase in women's empowerment index reduces children's likelihood of being anemic and having a co-occurrence of anemia and stunting in Sub-Saharan Africa. Women's empowerment is considered vital in child nutrition and is considered important throughout the first 1,000 days of life (Hastuti et al., 2022). Sey-Sawo et al. (2023) found that women's empowerment is associated with undernutrition among children under age 5 in The Gambia.

According to Debela, Gehrke, and Qaim (2020), improving child nutrition and empowering women are two important and closely connected development goals. Among the key components of the Sustainable Development Goals, empowering women and the promotion of children's nutrition (SDGs 2 and 5) are targeted for achievement by 2030 (Sey-Sawo et al., 2023).

This research focuses on how women's empowerment in agricultural activities could improve children's nutrition outcomes in rural households. This study assesses the

impact of women's empowerment on the nutritional status of children in rural areas of Burkina Faso. Specifically, the paper constructs an empowerment index in terms of women's capacity in decision-making in agricultural activities and assesses the effect of this index on children's nutrition. The paper assumes that more involvement of women in agricultural production decision-making will improve the nutritional status of children through access to improved food.

Agriculture is a major industry in Burkina Faso, and most of the agricultural production is for self-consumption. According to the National Gender Policy (PNG adopted in 2009), 75% of food production for household consumption is produced by women. Despite this important role played by women, in Burkina Faso they have limited access to land, credit facilities, agricultural inputs, equipment, extension services, market for their produce, education as well as training facilities compared to their male counterparts (Wekwete, 2014). In Burkina Faso, women's agricultural productivity is 20%-40% lower compared to men and these differences are mainly due to lower use of productive inputs (Udry, 1996).

However, the World Bank's current Women, Business and the Law report states that women legally have the same rights and opportunities as men to own assets and access credit in Burkina Faso (World Bank, 2023). Séogo and Zahonogo (2023) confirmed in their study of land property rights and agricultural productivity that now both customary and formal land tenure systems coexist in Burkina Faso after the formalization of the customary land system since 2009. The issue is that there is a gap between the law and the implementation on the ground. Indeed, there is a limited implementation and enforcement of land law for rural women as they are often neglected (TMG Research and GRAF, 2020).

Overall the nutrition situation in Burkina Faso remains a public health concern with all five indicators of child undernutrition, namely, low birth weight, global acute malnutrition, wasting, stunting, and underweight, above the WHO thresholds (Ouedraogo et al., 2020). The country is facing a double burden of malnutrition including undernutrition and overweight/obesity (Ouedraogo et al., 2020). From the 2019 National Nutrition Survey, 25.4% of children under 5 years old are stunted and 8.1% are wasted (MoH, 2020). Malnutrition is responsible for over one-third of child deaths in Burkina Faso (PNDES, 2016).

To the best of our knowledge, the only previous study on women's empowerment and child nutrition outcomes in Burkina Faso is an experimental one which evaluates the impact of empowering women on child nutrition through a nutrition-sensitive agricultural program (Heckert et al., 2019). The authors examined four domains of women's empowerment such as purchasing decisions, health care decisions, family planning decisions, and spousal communication and provided evidence that women's empowerment is a pathway to achieve impacts on child nutritional status, specifically wasting.

Thus, this paper is an extension of the previous that will provide empirical evidence for the link between women's empowerment and children's nutritional status in agricultural households. The paper contributes to existing empirical literature in three ways. First, it uses a national representative household dataset which will allow the determination of empowerment levels within agricultural households. Second, based on the well-known Women's Empowerment in Agriculture Index (Alkire et al., 2013), the paper uses alternative measures of empowerment to provide empirical evidence on the accurate effect of women's empowerment on children's nutrition outcomes in agricultural households. Third, the paper uses simultaneously the short-term and long-term nutrition outcomes to check if the effect of empowerment has a short or long run

effect on nutrition status. This research will therefore allow us to test the sensitivity of results based on empowerment measures and country context.

The results indicate a low level of empowerment in rural areas. But the empowerment index has a relatively high and positive correlation with children's nutritional outcomes. The robustness checks results indicate that among empowerment indicators, while production control has no direct correlation with nutrition, access to land and credit, income control, and social group membership are related to children's long- and short-term nutrition outcomes.

The rest of this paper is organized as follows. Section 2 provides an overview of empowerment measures. Section 3 presents the conceptual framework. Section 4 describes the data and explains the methodology while section 5 presents the results. Section 6 concludes the paper.

2. Overview of Women's Empowerment and Measures

Kabeer (2001) defines empowerment as "the expansion in people's ability to make strategic life choices in a context where this ability was previously denied to them". Malhotra et al. (2002) emphasize two elements important for understanding empowerment: process and agency. First, empowerment as a process involves change from a condition of disempowerment and denial of choice to one of empowerment. Second, agency means that "women themselves must be significant actors in the process of change that is being described". In other words, agency is the "ability to define one's goals and act upon them" (Kabeer, 1999).

According to Van den Bold et al. (2013), because processes of empowerment and the exercise of agency cannot be easily observed, proxy indicators are most commonly used in the literature to measure women's empowerment. There are various dimensions along which women can be empowered (economic, sociocultural, familial, interpersonal, legal, political and psychological) and also different levels at which

empowerment can occur: household and community, as well as national, regional and global (Malhotra et al., 2002).

In this conceptualization, individual- and household-level indicators are more related to direct measures than those at the aggregate level, such as national and regional, which are more related to indirect measures (Van den Bold et al., 2013).

At the individual and household level, there are attempts to measure women's empowerment more directly through the following (van den Bold et al., 2013): participation of women in household decision making; women's access to or control over resources; women's freedom of movement and mobility; power relations between husband and wife; spouses' attitudes towards domestic violence, and sources of power such as media exposure, education, or paid employment.

For Malhotra et al. (2002) this means a causal relation between these measures or proxies and empowerment. The authors conclude that as causality is often ambiguous, these measures are better defined as correlates or indirect measures of empowerment; where causality is clear, they may be defined as determinants or direct measures of empowerment (Samman and Santos 2009; Malhotra et al., 2002).

A specific index was developed to measure the empowerment of women in agriculture, the Women's Empowerment in Agriculture Index (WEAI). The WEAI is a survey-based tool co-developed by the International Food Policy Research Institute (IFPRI), the Oxford Poverty and Human Development Initiative, and the U.S. Agency for International Development (USAID) (Alkire et al., 2013).

The WEAI is an aggregate index based on individual-level data collected by interviewing men and women within the same households. It has two sub-indexes: the five domains of empowerment (5DE), and the gender parity index (GPI). The 5DE, assesses the degree to which women are empowered in five domains: Production, Resources, Income, Leadership and Time, through ten indicators (Alkire et al., 2013).

The GPI measures the percentage of women whose achievements are at least equal to those of men in their households (Alkire et al., 2013).

Both these indexes have values ranging from 0 to 1, with higher values reflecting greater empowerment. The overall WEAI is a weighted average of the 5DE and GPI, with weights of 0.9 and 0.1, respectively. A woman is defined as empowered if she has adequate achievements in four of the five domains or has achieved adequacy in 80% or more of the weighted indicators.

Since the original WEAI was released, multiple versions have been developed. The Abbreviated WEAI (A-WEAI) is a shorter version of the original that can be used in population-based surveys to measure women's empowerment (Malapit et al., 2015b). The pro-WEAI is a project level WEAI; it is a WEAI adapted to meet the need for monitoring projects and assessing their impact (Yount et al., 2019; Malapit et al., 2019).

3. Conceptual Framework

According to the framework, empowering women can affect children's nutrition outcomes through different pathways. The framework in Figure 1 below, shows that women's access to land and credit, their control over income and production and their membership in an association enable nutrition improvements for women themselves as well as for the overall household. When a woman has more input in productive decisions and autonomy in production, as well as more ownership of assets such as land, they can not only improve food production and, consequently, access to food, but also the income that is obtained from food production. Increases in food production should lead to increased food availability, access and, ultimately, food intake (Hawkes and Ruel, 2008).

The result is a positive effect on a child's diet, which has a positive effect on a child's nutritional status. It is expected that when women have more control over the use of income and access to credit, it means that they would spend more money on both

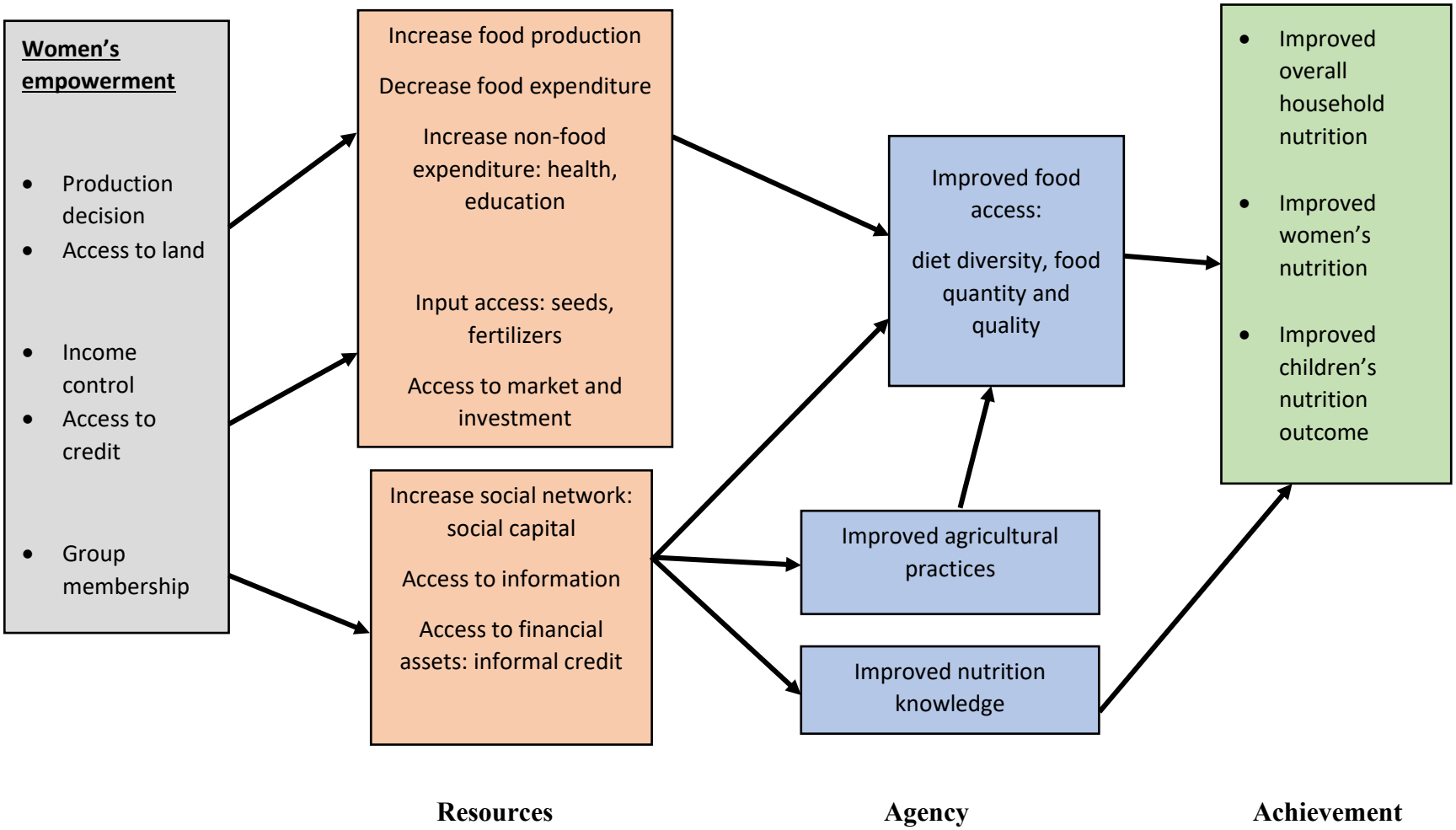
food and non-food expenditure. Indeed, cash controlled by women is more likely to be used to purchase food (Quisumbing and Maluccio, 2003), but also, more income also means more non-food expenditure, and therefore more money for health care and education (Santoso et al., 2019).

When women have control over income, they more frequently use it to buy food and health care for the family, especially for children (Smith et al. 2003). Also, if agricultural income accrues to household members more concerned with diet quality and nutrition it may lead to more spending on goods and services linked to nutrition outcomes (Quisumbing, 2003). However, in practice, a randomized experiment revealed that even income through cash transfers improves children's education and health outcomes, giving cash to fathers leads to better child nutritional outcomes than giving cash to mothers (Akresh et al., 2016). The authors pointed out the West Africa contextual cultural norm in their study as it is confirmed that fathers are seen as the responsible for providing food for the family.

Lastly, a social group is believed to have a positive influence on women regarding caring capacity and practices. In a social group, women can benefit from more information on agricultural activities and knowledge of good practice, which may help them develop their abilities in farming and nutrition.

Therefore, according to Hawkes and Ruel (2008), programs with components devoted to educating beneficiaries and informing them about the nutritional qualities of the foods they produce and consume have better nutritional outcomes than those that do not. Also, a social group might lead a woman to participate in a lending and savings group, increasing the availability of cash for her household (Santoso et al., 2019). This results in better food security and the availability of higher caloric foods for the household, specifically for children.

Figure 1: Link between women empowerment and nutrition



Source: Authors' compilation

4. Methodology and Data

To assess the impact of women's empowerment on child nutrition, a precise measure of women's decision-making power is needed, on the one hand and, a measure of children's nutrition on the other hand. First, the data source is discussed.

4.1 Data Source

This research uses data from the 2014 Continuous Multisectoral Survey (EMC) conducted by the National Institute of Statistics and Demography (INSD) of Burkina Faso.[2] The EMC is nationally representative of households (agricultural and non-agricultural). A two-stage stratification procedure was used as sampling technique to select more than 10,000 households in all 13 regions of the country.

The EMC collected a wide range of information on households and individuals, including household demographics, food and non-food expenditures, food security, agricultural production (such as land tenure, inputs costs and fertilizers), the economic situation of households, the occupational situation of persons over 15 years of age, possessing assets, access to information and communication technologies (ICT), health, education, savings and access to credit, access to social services (clean water and electricity) and anthropometric information on children under five.

As empowerment in the agricultural sector is measured in this study, we restrict our sample to farm households in rural areas with a woman present and with complete information on children's anthropometrics. This prevents the potential misclassification of individuals as empowered or not when they do not belong to agricultural communities (Malapit et al., 2015a).

We are aware that current data exist namely the 2018 EMC and the 2018/19 EHCVM (Harmonized Survey on Households Living Standards). However, there are constraints

[2] The 2014 EMC survey is part of the Living Standards Measurement Survey (LSMS) collection from the World Bank and represents the first one in Burkina Faso. Data are downloadable on the World Bank website at https://microdata.worldbank.org/index.php/home.

that prevent us from considering them. These data do not contain all the variables of interest for our topic in particular information on children's nutrition and anthropometrics. Then, this research will be our contribution to the literature of the time of used data (2014).

4.2 Measurement of Women's Empowerment Index in Burkina Faso

Several authors have highlighted the fact that empowerment is a multidimensional concept, and a complex process that can be interpreted differently as women who are empowered in one dimension are not necessarily empowered in others (Sharaunga et al., 2019; Bayissa et al., 2018; Pradeep and Deeksha, 2016; Malhotra et al., 2002).

A review of the literature shows that there is no agreement on the variables to be considered in measuring the degree of women's empowerment. In this study, we base our choice of variables on two criteria: the availability of data and the common variables in the literature (Alkire et al., 2013; Lépine and Strobl, 2013; Arulampalam et al., 2016; Bourdier, 2019).

Following Alkire et al. (2013), we therefore consider indicators of empowerment which are relevant in the Burkina Faso context. Due to data limitation, we focus on five variables as indicators: (i) control of production decisions; (ii) access to land; (iii) control over income; (iv) access to credit; and (v) social group membership. As presented in Table 1, a woman is defined as empowered if she has adequate achievement at least in four of the five indicators or has achieved adequacy in 80% (4/5). These variables emphasize the degree of women's responsibility not only in agricultural activities, but also in the decision-making process within the household. These two components (activities and decisions) provide a broad view of the decision-making power of women and go beyond the mere participation of women in agriculture.

Given the plurality of indicators, we chose to adopt a dual measure of empowerment. The first measure combines the variables into a composite index. The

second step, as a robustness check, is to independently use these indicators to establish their individual effect on children's nutrition.

Table 1: Indicators of women's empowerment used in the study

Indicator	EMC variables used	Modalities
Production decision	Woman decides on agricultural production activities	Yes, No
Access to land	Woman uses and/or owns land for production	Yes, No
Control over use of income	Woman has control over at least one type of income	Yes, No
Access to credit	Woman had credit from a financial institution/informal source in the last twelve months	Yes, No
Group member	Woman participates in a social group	Yes, No

Source: Authors' compilations from EMC 2014 data

Following Lépine and Strobl (2013), we used Multiple Correspondence Analysis (MCA) to generate a women's empowerment index, taking into account the five categorical variables presented in Table 1. MCA is more suited to discrete or categorical variables (Burger et al., 2006). Also, MCA makes fewer assumptions about the underlying distribution of indicator variables, i.e., MCA imposes fewer constraints on the data (Greenacre and Blasius, 2006). However, we use more detailed modalities on empowerment indicators to add heterogeneity to the index and make it more precise. Details of the modalities of empowerment indicators and the MCA results are presented in the Appendix.

The empowerment index is constructed as a variable named *"empowerment"* using the Burt matrix approach on five categorial variables. The weights used to construct the indicator are derived from the first dimension of MCA. The Appendix shows that access to land and control over production are variables that count the most in empowerment, while group membership contributes much less. Our aim is to determine how the level of empowerment affects children's nutrition.

4.3 Measurement of Nutrition Outcomes

The nutritional outcome of the child is measured by nutritional status. In general, two types of surveys can be used to assess the nutritional status of a population: consumption or food expenditure surveys, and anthropometric surveys. For the purpose of this study, we focus on anthropometric measures as they are simple statistical indicators that have the advantage of considering each individual. Indeed, an anthropometric measure is a variable that accounts for changes in the body size of any specific individual. The main anthropometric indicators commonly used to assess a child's nutritional status are "height-for-age", "weight-for-height" and "weight-for-age". Anthropometric indicators are used because they are a good general measure of child health (De Onis et al., 1993).

In this study, the z-score indicator is chosen in order to comply with the recommendations of the World Health Organization Growth Standards (WHO, 2006). The universal reference threshold value of "-2 standard deviation units (SD)" is used as the delimitation measure to separate malnourished children from those who are not malnourished. According to the WHO's conventional definition of child malnutrition, children are not considered malnourished when the indices are between -2SD and +2SD. However, when indices are below -2SD, children are malnourished and when indices are below -3SD, malnutrition is severe. Children are considered overweight or obese when the z-score index is greater than +2 standard deviations (+ 2SD).

This study includes two indicators, namely the weight-for-height (short-term indicator) index and the height-for-age (long-term indicator) index to analyze the nutritional status of children under five in Burkina Faso. We computed these indicators using the 2006 WHO Child Growth Standards (WHO Multicentre Growth Reference Study Group, 2006). Thus, a child is defined as stunted if their height-for-age z-score (HAZ) is 2 or more SD below the median of the reference group. When the weight-for-

height z-score (WHZ) is two or more standard deviations below the median of the reference group, the child is defined as wasted.

4.4 Estimation and Identification Strategy

To assess the impact of women's empowerment in agricultural activities on the nutritional status of children, we estimate a model of the following form:

$$Y_{ij} = \beta_0 + \beta_1 E_j + \beta_2 H_j + \beta_3 M_j + \beta_4 C_{ij} + \varepsilon_{ij} \quad (1)$$

where Y_{ij} represents the nutrition outcome for child i in household j including height-for-age (HAZ), and weight-for-height (WHZ) z-scores, and then two separate regressions are run for each nutrition outcome; E_j is the empowerment index in agriculture for each woman in household j; household j characteristics (H_j); woman in household j characteristics (M_j); and child's characteristics (C). β_0 is the constant term which captures other factors, and the error term is ε, which is assumed to be uncorrelated with all regressors.

Household characteristics include household size, gender, age and literacy of the household head, number of crops produced, and whether the household has access to clean water or sanitation. Women's control variables include age, education and literacy, and marital status. Children's characteristics include age, gender and participation in a growth or nutrition program. The equations can be estimated by a simple ordinary least squares (OLS) method. However, there is a chance that the estimate may be biased by different sources as endogeneity of empowerment.

Endogeneity of Empowerment Measure

This case examines the potential endogeneity of women's empowerment as one possible source of bias in estimating Equation 1. Indeed, empowerment is likely to be affected by the very same factors that influence children's nutrition (Malapit et al., 2015a; Malapit et al., 2018). According to Lépine and Strobl (2013), there are at least two explanations for the likely endogeneity of empowerment. The first is that women's

decision-making power could be associated with healthy children if mothers with better intrinsic characteristics have the most independence. In this case, the effect of empowerment could be overdetermined. By contrast, the second explanation assumes that if "neglected women" are more autonomous, the high degree of subsequent empowerment may be associated with poor nutritional health for children. In this case, the effect of empowerment would be underestimated (Lépine and Strobl, 2013).

Given the possibility of an endogeneity bias, two solutions can be envisaged. The first solution is to use the technique by Strauss (1986). This technique consists of building an empowerment indicator that assigns average values of empowerment to all women in the same stratum. This circumvents the endogeneity that would come from an individual measure of empowerment. The second solution is the use of instrumental variables (IV) with the risks of validity and robustness of instruments. The present study attempts these two techniques to correct for potential endogeneity bias.

We estimated Equation 1 using the OLS method with the average empowerment index by stratum as empowerment measure to take account of the external effect at the community level. This is because a woman who could be considered less empowered individually but living in a community where women's empowerment is high, will benefit from this externality. As an example, women in communities or villages close to a market have more access to economic opportunities and can provide their children with better nutrition.

We also attempted to address the potential endogeneity bias with standard IV techniques. According to Wouterse (2016), one may use instrumental variable methods to obtain consistent estimates in the presence of endogeneity. Thus, the instruments that the researcher uses must be sufficiently correlated with the empowerment variable, but not correlated with the nutrition outcome. We use a set of instruments including (1) the number of male children in household, (2) the presence of household head's mother,

(3) the presence of other female relative in the household, and the (4) the time to reach the nearest market. These instruments in the country context are likely to be correlated with empowerment and are exogenous to the current nutritional status of children.

4.5 Descriptive Statistics

This section presents the descriptive statistics of variables used in this study in Table 2 (key variables) and Table A3 (in the Appendix). Table A3 shows that, on average, an under five child in Burkina Faso is 29 months old, and 39% of children are under two years of age. In addition, 49% of children are female. About 28% of children are stunted, and 9% wasted. Table 2 also shows that 42.3% and 21.1% of children, respectively, are enrolled in a growth program and a nutrition program.

Table A3 (in the Appendix) shows that households are large, with a mean household size of 11 members. Fewer than 5% of households are headed by a woman, and 75% of household heads are not literate. On average, rural adults have a low level of education. While a household head would have spent fewer than two years at school, women had less than one year of schooling. On average, over 60% of households have access to clean water, but only 5% have access to sanitation. Households spent 55% of their total expenditures on food. Over 90% of households used local seed to produce, on average, five crops per plot and, on average, households have four plots for cultivation. However, 75% of these plots are used by households to produce only one crop for consumption. The main crops produced by households are sorghum, millet, maize, cowpeas, peanuts and cotton. While cereals are food crops in Burkina Faso, cotton and peanuts are considered cash crops.

Table 2 shows that production decisions contributed most to the empowerment of rural women, while access to credit contributed the least: 87% of women had made decisions about agricultural production and about 42% of women controlled at least

one source of income, while less than 5% had access to credit. While 20% of women participated in a social group, only 9% had access to and/or owned land. However, Table A1 shows that production control (42%) and access to land (44%) contribute more to the empowerment index from the MCA computation. Table A2 reveals that production control and access to land contribute to the empowerment of all women (head of a household, spouse and other relative). While the income contribution is higher for a head of household (18.4%), access to land contributes more to empowering a spouse (46.4%) and other women (41.7%) in a household.

Table 2: Summary statistics (key variables)

Variable	Obs.	Mean	Std. dev	Min	Max	Definition
Nutrition outcomes						
HAZ	5,710	-1.068	1.756	-6	5.93	Height-for-age z-score
WHZ	5,710	-0.299	1.414	-5.68	5.85	Weight-for-height z-score
Stunted	5,710	0.276	0.447	0	1	1 if HAZ<-2
Wasted	5,710	0.092	0.289	0	1	1 if WHZ<-2
Empowerment indicators						
Empowerment score	5,710	1.655	0.850	0	5	Women empowerment score generated
Empowerment index	5,710	-0.00033	1.000	-0.59	4.76	Women empowerment index generated
Empowered	5,710	0.021	0.143	0	1	1 if woman empowerment score ≥4
Control over production	5,710	0.877	0.327	0	1	1 if woman makes production decision
Control over land	5,710	0.091	0.288	0	1	1 if woman has access or owns land
Control over income	5,710	0.440	0.496	0	1	1 if woman controls at least one income
Access to credit	5,710	0.050	0.218	0	1	1 if woman got credit in last 12 months
Group membership	5,710	0.195	0.396	0	1	1 if woman is a social or economic group member
Instruments						
Male children in household	5,710	1.567	1.416	0	12	"Number of male children in household"
Mother-in-law	5,710	0.105	0.307	0	1	"Mother of household head is present"
Other woman	5,710	0.208	0.406	0	1	"Another female relative is present"
Market time	5,708	34.02	20.87	7	60	"Average time in minutes to reach the nearest market"

Source: Data analysis from EMC 2014
Note: See Appendix Table A3 for the complete summary.

Table 2 shows that the average empowerment score for each woman was 1.655 meaning that, on average, each woman had access to less than two empowerment indicators. Table 3 shows that the distribution of empowerment score reveals that over 95% of women had an empowerment score below 4, and fewer than 1% had all the

indicators of empowerment. Most women had access to one (43%) or two (37%) empowerment indicators. Table A2 (in the appendix) reveals that while women who are household heads had access to three empowerment indicators, spouses and "other" women had access to fewer than 2 indicators.

Table 3: Distribution of women's empowerment score

Empowerment score	Freq.	Per cent	Cumulative percentage
0	268	4.69	4.69
1	2,444	42.80	47.50
2	2,111	36.97	84.47
3	767	13.43	97.90
4	112	1.96	99.86
5	8	0.14	100
Total	5,710	100.00	

Source: Data analysis from EMC 2014

5. Results and Discussion

We present our key results for OLS and IV estimates (2SLS) of HAZ and WHZ in Table 4. IV diagnostics are reported at the end of the table, but first-stage results are excluded. The key statistics Hansen J statistics test for over-identification and the Kleibergen-Paap rk Wald F statistic of weak exogeneity indicate that our set of instruments are valid and relevant, and the models were identified. However, while we cannot reject the null hypothesis that empowerment is exogenous for WHZ regressions, the endogeneity test indicates that empowerment is endogenous for HAZ regressions. Then, we discuss the IV estimates for HAZ, and the OLS estimates for WHZ.

Even controlling for the endogeneity of the empowerment measures using the average index by stratum and IV, we interpret estimated coefficients from OLS for WHZ and from IV for HAZ as associative or correlations rather than causal relationships (Malapit et al., 2015a; Malapit et al., 2018; Bourdier, 2019).

Our regressions are clustered and based on all women sampled and we control when a woman is head of household. In Table 4, columns 1 and 4 present OLS results without controlling for empowerment, i.e., using the computed empowerment index for HAZ,

and WHZ, respectively. The other columns show the results for controlling for endogeneity of empowerment. While columns 2 and 4 show the OLS results from the average index, columns 3 and 6 present these results from IV from HAZ and WHZ respectively. This enables us to check how sensitive our results are depending on empowerment measures.

Table 4's results reveal that once we control for endogeneity, the empowerment coefficient rises considerably, but coefficients of control variables remain substantially similar. This suggests that not controlling for endogeneity of women's empowerment tends to underestimate its effect on child nutrition. Note that we add in regressions interaction with empowerment. Our interpretations are then based on OLS using the average empowerment index for WHZ and IV for HAZ.

Table 4: Women's empowerment index and children's nutrition outcomes

Variable	**HAZ**			**WHZ**		
	Index	**Avg. index**	**2SLS**	**Index**	**Avg. index**	**2SLS**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Empowerment index	0.076**	0.291*	0.905**	0.003	0.137	0.348
	(0.037)	(0.171)	(0.442)	(0.036)	(0.171)	(0.385)
Child characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Woman characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Interaction with empowerment						
Empowerment*girl	-0.056	-0.013	-0.586**	0.012	0.012	-0.208
	(0.039)	(0.037)	(0.285)	(0.037)	(0.033)	(0.248)
Empowerment*nutrition programme	0.074	0.105	-0.218	-0.089*	-0.085*	-0.210
	(0.068)	(0.067)	(0.179)	(0.049)	(0.048)	(0.144)
Empowerment*polygamy	-0.006	0.027	-0.422*	0.069	0.069*	-0.103
	(0.053)	(0.048)	(0.226)	(0.045)	(0.041)	(0.197)
Constant	1.688***	1.709***	1.776***	0.044	0.057	0.078
	(0.316)	(0.315)	(0.334)	(0.286)	(0.287)	(0.293)
Cluster	535	535	535	535	535	535
Observations	5,656	5,656	5,654	5,656	5,656	5,654
F	30.10	30.11	30.18	3.57	3.57	3.58
R-squared	0.130	0.130	0.056	0.020	0.021	0.002
Hansen J p, Ho: Instruments valid			0.3923			0.9069
Under ID test p, Ho: Underidentified			0.000			0.000
Weak ID test stat (Kleibergen-Paap rk Wald F)			20.26			20.26
Anderson-Rubin, Ho: endogvars irrelevant						
A-R Wald test, p-value			0.0962			0.8493
A-R Wald Chi2 test, p-value			0.0927			0.8480
Endogeneity test p, Ho: exogenous			0.0511			0.3642
First stage F statistic (4, 543)			12.20			12.20

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses

IV First-stage results are excluded (available from authors upon request). Full results are available from authors.

5.1 Women's Empowerment Index

The results of the clustered OLS estimates in Table 4 show that women's empowerment is positively correlated with HAZ and WHZ but the correlation is not significant for WHZ. This shows that there is evidence that empowerment is more associated with long-term nutrition outcomes. Column 5 shows that empowerment favors HAZ by a standard deviation of 0.904 (against 0.076 and 0.291 standard deviation for a simple and average index respectively). These results are in line with those previously found in the literature (Lépine and Strobl, 2013; Malapit and Quisumbing, 2015; Arulampalam et al., 2016; Shiwakoti et al., 2017; Heckert et al., 2019). Malapit et al. (2015a) found similar results when combining OLS and IV.

Also, our result is robust compared to Malapit and Quisumbing (2015) who, by using OLS without controlling for empowerment endogeneity, found a slight association between empowerment and child nutrition outcomes. Shiwakoti et al. (2017) show that Nepalese women with low empowerment have children who are underweight and stunted. This suggests that improving women's position in household-level decision making translates into significant gains for the nutritional status of the children. Ibrahim et al. (2015) highlighted this further by pointing out that there is a positive relationship between women's active participation in decision making and children's health, and the correlation is underestimated when endogeneity is not taken into account.

The results of Smith et al. (2003) are even more positive, showing that there is no doubt that better statuses for women have a positive and significant impact on the nutritional status of children. Scantlan and Previdelli (2013) found a positive and independent effect of women's empowerment on child nutrition. According to these authors, women's empowerment alone could serve as a lever for targeting the goal of reducing child malnutrition. However, Malapit et al. (2018) found that women's empowerment has no direct correlation with child nutrition outcome in Bangladesh.

5.2 Child Characteristics

Child sex has a significant correlation with nutrition outcome. Indeed, being a girl is negatively related to WHZ. The interaction variable shows that the correlation is indirect for HAZ. This means that girls benefit less from empowerment than boys. This is because in a rural household child sex preference could lead parents to take more care of boys than girls. This result confirms Malapit et al. (2015b) who found a negative correlation with being a girl when empowerment is measured by credit decision.

Child age is correlated negatively to HAZ, and age-squared indicates that there is a threshold where age is positively associated with HAZ. Indeed, the age group variable shows that children beyond two years of age benefit more from women's empowerment than those under two. This can be explained by the fact that children above two benefit more directly from agricultural production and diet quality and diversity as they are nourished in the same way as household adults. This result is consistent with Makoka (2013), Lépine and Strobl (2013), and Malapit et al. (2018).

However, the results show a negative correlation between nutrition program. The interaction variable reveals that the correlation is direct for HAZ but indirect for WHZ. When a child participates in a nutrition program his/her z-score is reduced by 0.267 SD in the long term and by 0.087 SD in short term. This observation could be explained by the fact that sometimes, because of low literacy levels, women cannot fully understand Infant and Young Child Feeding (IYCF) practices. Also, the financial cost could prevent some women from participating regularly, as could the lack of complementary nutritious food distribution for children.

5.3 Women's Characteristics

Overall, women's characteristics have a mixed correlation with child nutrition outcome. A woman's age has no significant association with nutrition outcomes and is

contradicting negative but very weakly related to WHZ. Compared to single women, women in polygamous and monogamous relationships yields a negative and significant correlation with child HAZ. The interaction indicates that the negative correlation in polygamy is higher for HAZ (0.422 SD) but the correlation is positive for WHZ (0.069 SD). These results contradict with Bourdier (2019) who also found a mixed effect of women's marital status in Ghana. Indeed, this author found that in polygamous households, women's empowerment is positively correlated with HAZ but negatively correlated with WHZ.

Our results reveal that when a woman is household head there is a negative correlation with child's long-term nutrition outcome, a positive but insignificant correlation with WHZ. We assume here that women's status in a household is not a sufficient condition for child well-being. For us, women's status (spouse or head) has an indirect effect on their children and there are pathways through which their status could affect nutrition within the household.

In addition, women's literacy has a mixed effect on nutrition outcome. While literacy has a positive correlation with WHZ, HAZ is not correlated with literacy. However, in the literature, education is found to positively affect child nutrition (Radhakrishna and Ravi, 2004; Glewwe, 1999; Thomas, 1994).

5.4 Household Characteristics

Results reveal that age of household head and household size are not linked to child nutrition outcomes in rural households. These results are consistent with Bourdier (2019) and Malapit et al. (2018). In addition, household head literacy has no significant correlation to nutrition outcomes. This result contradicts Malapit et al. (2018) who found that household head education is positively and highly correlated to HAZ but has no relationship with WHZ.

Results also show that while household size has no correlation with nutrition outcome, access to social services has a mixed association. While access to clean water has no relationship with nutrition outcomes, access to sanitation is positively correlated with the short-term outcome WHZ. Meanwhile, Malapit et al. (2018) found that access to electricity is positively associated with WHZ. These negative effects (education and access to clean water) could be explained by the existence of an interaction effect.

5.5 Robustness Checks

For a robustness check, a clustered OLS was run using the five empowerment indicators as empowerment measures. As for empowerment indicators, results show mixed associations, i.e., while some indicators are positively correlated to nutrition outcome, other are negatively or not significantly associated.

Appendix Table A4 shows that access to land is positively correlated to HAZ indicating that women's access to land favors long-term nutritional status. While access to credit is negatively related to WHZ, social group membership is positively correlated with the long-term outcome of HAZ. Control over income is negatively associated with HAZ (long-term outcome) indicating that current income is not sufficient to support long-term nutrition. Table A4 indicates that production control is the only indicator that has no significant correlation with nutrition outcome, although the association is positive for HAZ.

In Table A1, figures reveal that although production control highly contributes to the empowerment index (0.418), only individual decisions really matter (0.313). Indeed, among the 87% of women who participated in production decisions, 88% decide collectively or jointly, but this collective decision contribution to empowerment is too low to matter (0.076 in Appendix Table A1). We suggest that the positive correlation with the empowerment index is from land access, income control and group membership. This justifies the multidimensionality of empowerment. Indeed, a woman

could be empowered in one indicator and not in another. Therefore, empowerment must be measured by a set of indicators instead of using single indicators, and the components must relate to the domain in which empowerment is measured.

6. Conclusion and Policy Implications

This study analyzed the effect of women's empowerment on child nutrition in rural Burkina Faso. We assumed that an improvement in women's empowerment is beneficial for the nutritional status of children. We used nationally representative data from the 2014 Multisectoral Continuous Survey to develop a composite measurement of empowerment and explored two techniques to deal with the potential endogeneity of empowerment. Children's nutrition outcomes were measured by the following anthropometrics: height-for-age z-score (long term) and weight-for-height (short term) z-score. Our results show that women's empowerment has a positive and high correlation with child long term nutrition outcomes. While child characteristics are related to their nutrition outcomes, women's and households' characteristics are weakly correlated with nutrition outcomes. Even in the literature, there is no consensus on the variables to be included in the measure of empowerment, our results are convergent with several studies in different socioeconomic contexts.

Our results point out two implications. First, as results indicate that our measure of women's empowerment is highly correlated with children's nutritional status, we suggest that programs targeting women's empowerment could be implemented at the community level to reach most women. Second, public policies aimed to improving empowerment should be integrated with measures facilitating women's access to land and other agricultural inputs by updating laws on land ownership and land inheritance for women. There are national policies and laws, but they are hindered at the local level by socio-culturally rooted norms and practices, and a lack of resources.

References

Akresh, R., D. de Walque and H. Kazianga. (2016). Evidence from a Randomized Evaluation of the Household Welfare Impacts of Conditional and Unconditional Cash Transfers Given to Mothers or Fathers. World Bank Policy Research Working Paper 7730, World bank.

Alkire, S., R. Meinzen-Dick, A. Peterman, A. Quisumbing, G. Seymour and A. Vaz. 2013. "The Women's Empowerment in Agriculture Index". *World Development*, 52: 71–91.

Arulampalam, W., A. Bhaskar and N. Srivastava. 2016. "Does Greater Autonomy Among Women Provide the Key to Better Child Nutrition?" IZA Discussion Paper No.9781, Institute for the Study of Labor, http://ftp.iza.org/dp9781.pdf.

Bayissa, F.W., J. Smits and R. Ruben. 2018. "The multidimensional nature of women's empowerment: Beyond the economic approach." *Journal of International Development*, 30(4): 661–90, DOI: 10.1002/jid.3268

Belesova, K., A. Gasparrini, A. Sié, R. Sauerborn and P. Wilkinson. 2017. "Household cereal crop harvest and children's nutritional status in rural Burkina Faso." *Environmental Health*, 16: 65, DOI: 10.1186/s12940-017-0258-9

Bhagowalia, P., P. Menon, A.R. Quisumbing and V. Soundararajan. 2012. *What Dimensions of Women's Empowerment Matter Most for Child Nutrition? Evidence Using Nationally Representative Data from Bangladesh*. IFPRI Discussion Paper No.1192. International Food Policy Research Institute (IFPRI), Washington D.C.

Bhutta, Z.A., M. Chopra, H. Axelson, P. Berman, T. Boerma, J. Bryce, et al. 2010. "Countdown to 2015 decade report (2000-10): taking stock of maternal, newborn, and child survival." *Lancet,* 375:2032–44.

Black, R.E., L.H. Allen, Z.A. Bhutta et al. 2008. "Maternal and child undernutrition: global and regional exposures and health consequences." *Lancet*, 371: 243–60.

Bourdier, T. 2019. "Women's Empowerment and Child Nutrition in Polygynous Households of Northern Ghana". IFPRI Discussion Paper No. 01809. International Food Policy Research Institute (IFPRI), Washington D.C.

Burger, R., F. Booysen, S. van der Berg and M. von Malitz. 2006. *Marketable Wealth in a Poor African Country: Using an Index of Consumer Durables to Investigate Wealth Accumulation by Households in Ghana*. Research Paper No. 2006/138. Helsinki: UNU-WIDER.

Cameron, A.C. and P.K. Trivedi. 2005. *Microeconometrics: Methods and Applications*. Cambridge University Press, New York.

Christian, A. K., Atiglo, D. Y., Okyere, M. A., Obeng-Dwamena, A., Marquis, G. S., & Jones, A. D. (2023). Women's empowerment, children's nutritional status, and the mediating role of household headship structure: Evidence from sub-Saharan Africa. *Maternal & Child Nutrition*, 19 e13520. https://doi.org/10.111/mcn.13520.

De Onis M., C. Monteiro, J. Akré and G. Clugston. 1993. "The worldwide magnitude of protein energy malnutrition: An overview from the WHO global database on child growth." *Bulletin of the World Health Organization*, 71: 703–12.

Debela,B., L., E. Gehrke and M. Qaim. (2020). Links Between Maternal Employment and Child Nutrition in Rural Tanzania. *American Journal of Agricultural Economics*,103(3):812-830; doi:10.1111/ajae.12113.

Doss, C., C. Kovarik, A. Peterman, A.R. Quisumbing and M. van den Bold. 2013. *Gender Inequalities in*

Ownership and Control of Land in Africa: Myths versus Reality, IFPRI Discussion Paper No. 1308.

FAO (Food and Agriculture Organization of the United Nations) (2011). Women in agriculture: Closing the gender gap for development. Rome

Glewwe, P. 1999. "Why does mother's schooling raise child health in developing countries? Evidence from Morocco." *Journal of Human Resources*, 34(1): 124–59.

Greenacre, M. and J. Blasius, eds. 2006. *Multiple Correspondence Analysis and Related Methods*. Chapman and Hall/CRC Press, London, 4-40.

Hastuti, A. P, Sukartini, T., Arief Y. S., Nursalam, N., Mufarokhah, H.(2022). Women's Empowerment to Improve Nutritional Status in Children: A Systematuc Review. Open Access *Maced J Med Sci.*; 10(F):41-47. https://doi.org/10.3889/oamjms.2022.8026.

Hawkes, C. and M.T. Ruel. 2008. *From Agriculture to Nutrition: Pathways, Synergies and Outcomes*. Agriculture and Rural Development Notes No. 40. The World Bank, Washington, D.C.

Heckert, J., D.K. Olney and M.T. Ruel. 2019. "Is women's empowerment a pathway to improving child nutrition outcomes in a nutrition-sensitive agriculture program? Evidence from a randomized controlled trial in Burkina Faso." *Social Science & Medicine,* 233: 93–102.

Herforth, A., A. Jones and P. Pinstrup-Andersen. 2012. *Prioritizing Nutrition in Agriculture and Rural Development: Guiding Principles for Operational Investments*. Health, Nutrition and Population (HNP) Disussion Paper No. 74152. , The World Bank, Washington D.C.

Ibrahim, A., S. Tripathi and A. Kumar. 2015. "The effect of women's empowerment on child health status: Study on two developing nations." *International Journal of Scientific and Research Publications*, 5(4): 2250–3153.

IFAD. 2019. *Burkina Faso Country Strategic Opportunities Programme 2019–2024*. Document EB 2019/126/R.17, The *International Fund for Agricultural Development* (*IFAD*), Executive Board — 126th Session Rome, 2-3 May 2019.

Kabeer, N. 1999. "Resources, agency, achievements: Reflections on the measurement of women's empowerment." *Development and change*, 30(3): 435–64.

Kabeer, N. 2001. "Conflicts over credit: Re-evaluating the empowerment potential of loans to women in rural Bangladesh." *World Development*, 29(1): 63–84.

Lépine, A. and E. Strobl. 2013. "The effect of women's empowerment on child nutrition in rural Senegal." *World Development*, 45(5): 17–30. Available at: https://doi.org/10.1016/j.worlddev.2012.12.018

Makoka, D. 2013. "The Impact of Maternal Education on Child Nutrition: Evidence from Malawi, Tanzania, and Zimbabwe." DHS Working Paper No. 84, ICF International Calverton, Maryland, USA.

Malapit, H., A.R. Quisumbing, R. Meinzein-Dick, G. Seymour, E.M. Martinez, J. Heckert, D. Rubin, A. Vaz and K.M. Yount. 2019. "Development of the project-level Women's Empowerment in Agriculture Index (pro-WEAI)." World Development, 122: 675–69.

Malapit, H.J.L. and A.R. Quisumbing. 2014. *What Dimensions of Women's Empowerment in Agriculture Matter for Nutrition-related Practices and Outcomes in Ghana?* IFPRI Discussion Paper No.1367. International Food Policy Research Institute (IFPRI), Washington D.C., USA. Available at: https://ssrn.com/abstract=2486810

Malapit, H.J.L. and A.R. Quisumbing. 2015. What dimensions of women's empowerment in agriculture matter for nutrition in Ghana? *Food Policy*, 52: 54–63.

Malapit, H.J.L., E. Sraboni, A.R. Quisumbing and A. Ahmed. 2015a. Gender Empowerment in Agriculture and Children's Well-Being in Bangladesh. IFPRI Discussion Paper 01470, International Food Policy Research Institute (IFPRI).

Malapit, H.J.L., E. Sraboni, A.R. Quisumbing and A.U. Ahmed. 2018. "Intrahousehold empowerment gaps in agriculture and children's well-being in Bangladesh." *Development Policy Review*, 37:176–203.

Malapit, H.J.L., S. Kadiyala, A.R. Quisumbing, K. Cunningham and P. Tyagi. 2015b. "Women's empowerment mitigates the negative effects of low production diversity on maternal and child nutrition in Nepal." *The Journal of Development Studies*, 51(8): 1097–123. Available at: https://doi.org/10.1080/00220388.2015.1018904

Malhotra, A., S.R. Schuler and C. Boender. 2002. "Women's empowerment as a variable in international development." Background Paper for the World Bank Workshop on Poverty and Gender: New Perspectives, Washington D.C: World Bank.

Melesse, M. B. (2021). The effect of women's nutrition knowledge and empowerment on child nutrition outcomes in rural Ethiopia. *Agricultural Economics*, 1–17. https://doi.org/10.1111/agec.12668.

MoH (Ministry of Health). 2020. "Enquête Nutritionnelle Nationale 2019. " Rapport final Smart 2019,Ministère de la Santé, Burkina Faso (February 2020).

Nordman, C.J. and S. Sharma. 2016. "The power to choose: Gender balance of power and intra-household educational spending in India." WIDER Working Paper 2016/ 61. UNU-WIDER, Helsinki (May 2016). Available at: https://doi.org/10.35188/UNU-WIDER/2016/104-8.

Onah, M. N. (2021). Women's empowerment and child nutrition in South-Central Asia; how important is socioeconomic status? *SSM - Population Health* 13, 100718. https://doi.org/10.1016/j.ssmph.2020.100718.

Ouédraogo, M., O. Ouédraogo, U. Zongo, S. Kabore, E.A. Bambara and D. Sanou. 2020. "Nutrition situation of Burkina Faso: A narrative review". *North Africa Journal of Food and Nutrition Research. Special Issue*, 04(09): S36–S45. Available at: https://doi.org/10.5281/zenodo.4286605

Quisumbing, A.R. 2003. "What have we learned from research on intrahousehold allocation?" In A.R. Quisumbing, ed., *Household Decisions, Gender, and Development: A Synthesis of Recent Research*. Washington, D.C.: International Food Policy Research Institute (IFPRI).

Quisumbing, A.R. and J.A. Maluccio. 2003. "Resources at marriage and intrahousehold allocation: Evidence from Bangladesh, Ethiopia, Indonesia, and South Africa." *Oxford Bulletin of Economics and Statistics*, 65(3): 283–327.

Radhakrishna, R., and C. Ravi. 2004. "Malnutrition in India : Trendss and Determinants." *Economic and Political Weekly*, Vol. 39, No. 7, pp. 671-676.

Samman, E. and M.E. Santos. 2009. "Agency and Empowerment: A review of concepts, indicators and empirical evidence." OPHI Research Paper 10a, Oxford Poverty & Human Development Initiative (OPHI), University of Oxford.

Santoso, M. V., R. B. Kerr, J. Hoddinott, P. Garigipati, S. Olmos, and S.L. Young. 2019. "Role of women's empowerment in child nutrition outcomes: A systematic review". *Advances in Nutrition,* 10:1138–1151. doi: https://doi.org/10.1093/advances/nmz056.

Scantlan, J. and A. Previdelli. 2013. "Women's empowerment and childhood malnutrition in Timor-Leste: A mixed-methods study." Portland, Oregon: Mercy Corps, *1*, 1–53.

Seebens, H. 2011. "Intra-household bargaining, gender roles in agriculture and how to promote welfare enhancing changes." ESA Working Paper No. 11–10. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Séogo, W and Zahonogo, P. (2023). Do land property rights matter for stimulating agricultural productivity? Empirical evidence from Burkina Faso. *Land Use Policy*, Volume 125, 106475. https://doi.org/10.1016/j.landusepol.2022.106475.

Sey-Sawo, J., Sarr, F., Bah, H. T., and Senghore, T. (2023). Women's empowerment and nutritional status of children in the Gambia: further analysis of the 2020 Gambia demographic and health survey. *BMC Public Health,* 23:583. https://doi.org/10.1186/s12889-023-15494-1.

Sharaunga, S., M. Mudhara and A. Bogale. 2019. "Conceptualisation and measurement of women's empowerment revisited". *Journal of Human Development and Capabilities*, 20(1): 1–25. DOI: 10.1080/19452829.2018.1546280

Shiwakoti, R., M. Devkota and R. Paudel. 2017. "Women's empowerment and nutritional status of their children: A community-based study from villages of Bhaktapur District, Nepal." *Universal Journal of Public Health*, *5*(1): 8–16. Available at: https://doi.org/10.13189/ujph.2017.050102

Smith, L.C., U. Ramakrishnan, A. Ndiaye, L. Haddad and R. Martorell. 2003. "The importance of women's status for child nutrition in developing countries." Research Report No. 13. International Food Policy Research Institute (IFPRI), Washington, D.C.

Sraboni, E., H.J. Malapit, A.R. Quisumbing and A.U. Ahmed. 2014. "Women's empowerment in agriculture: What role for food security in Bangladesh?" *World Development*, 61: 11–52. Available at: http://dx.doi.org/10.1016/j.worlddev.2014.03.025

Strauss, J. 1986. "Does better nutrition raise farm productivity?" *Journal of Political Economy*, 94(2): 297–320.

Thomas, D. 1994. "Like father like son: Like mother like daughter: Parental resources and child health." *Journal of Human Resources*. 29(4): 950–88.

TMG Research and GRAF (2020). Securing Land Access For Women: An innovative process based on social legitimacy. Technical Guide, TMG Research gGmbH (TMG) and Groupe de Recherche et d'Action sur le Foncier (GRAF).

Udry, C. 1996. "Gender, agricultural production, and the theory of the household." *Journal of Political Economy*, 104: 1010–46.

UNICEF. 2019. "The state of the world's children 2019. Children, food and nutrition: Growing well in a changing world. UNICEF, New York.

United Nations General Assembly. (2015). *Transforming our world : the 2030 Agenda for Sustainable Development*, A/RES/70/1, available at: https://www.refworld.org/docid/57b6e3e44.html [accessed 1 August 2023]

Van den Bold, M., A.R. Quisumbing and S. Gillespie. 2013. *Women's Empowerment and Nutrition: An Evidence Review*. IFPRI Discussion Paper No. 1294. International Food Policy Research Institute (IFPRI), Washington D.C. http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/127840

Wekwete, N.N. 2014. "Gender and economic empowerment in Africa: Evidence and policy." *Journal of African Economies*, 23(Suppl_1): i87–i127. DOI: doi:10.1093/jae/ejt022

WHO (World Health Organization) Multicentre Growth Reference Study Group. 2006. "WHO child growth

standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development." World Health Organization, Geneva.

World Bank (2023). Women, Business and the Law 2023. Washington, DC: World Bank. doi:10.1596/978-1-4648-1944-5.

Wouterse, F. 2016. "*Empowerment and Agricultural Production Evidence from Rural Households in Niger*." IFPRI Discussion Paper No. 01509. International Food Policy Research Institute (IFPRI), Washington D.C.

Yount, K.M., Y.F. Cheong, L. Maxwell, J. Heckert, E.M. Martinez and G. Seymour. 2019. "Measurement properties of the project-level Women's Empowerment in Agriculture Index." *World Development*, 124, 19pp DOI: https://doi.org/10.1016/j.worlddev.2019.104639

Appendixes

Table A1: Construction of women's empowerment index: Multiple correspondence analysis (n=5,710)

Categories	Weight	Contribution to index
Production control		***0.418***
No control	1.096	0.029
Collective	-0.704	0.076
Individual	3.824	0.313
Access to land		***0.435***
No access	-0.468	0.040
User or owner	4.636	0.395
Control over source of income		***0.119***
No income	-0.348	0.014
Transfer	3.150	0.065
Household savings	0.092	0.001
Sale income	3.448	0.039
Access to credit		***0.024***
No credit	-0.081	0.001
Credit the last 12 months	1.523	0.023
Social group membership		**0.005**
No membership	-0.075	0.001
Member or decision maker	0.310	0.004
Percentage explained by dimension		64.34

Source: Authors' calculations

Table A2: Statistics on empowerment and nutrition outcomes by woman's status in household

Variable	Woman is head (I)	Woman is spouse (II)	Woman is other relative (III)	(I)+(II)
Empowerment				
Empowerment score	2.938	1.719	1.366	1.774
Empowerment index	0.915	0.030	-0.291	0.119
Difference in age with HH	-	12.667	14.159	12.081
Indicators of empowerment contribution				
Production control	0.492	0.468	0.479	-
Access to land	0.243	0.464	0.417	-
Control over income	0.184	0.068	0.096	-
Access to credit	0.016	0.000	0.006	-
Group membership	0.064	0.000	0.002	-
Nutrition outcomes				
Household child	0.760	0.907	0.667	0.900
Height-for-age Z-score (HAZ)	-1.338	-1.11	-1.150	-1.1210
Weight-for-height Z-score (WHZ)	-0.156	-0.2457	-0.240	-0.2415
Child is stunted	0.3489	0.2814	0.2975	0.2846
Child is wasted	0.119	0.0855	0.1039	0.0871

Source: Authors' calculations

Table A3: Summary statistics

Variable	Obs.	Mean	Std. dev	Min	Max	Definition
Woman's individual characteristics						
Age of woman	5,710	34.276	15.153	18	99	Age of woman in completed years
Education of woman	5,646	0.476	1.958	0	16	Number of years education
Woman literacy	5,697	0.110	0.312	0	1	1 if woman is literate
Woman level of education (ref.= no education)						
Primary education	5,645	0.042	0.202	0	1	1 if obtained primary education
Secondary education	5,645	0.021	0.146	0	1	1 if obtained secondary education
Woman marital status						
Single	5,697	0.177	0.382	0	1	1 if woman is single or in a simple cohabitation relationship
Monogamous union	5,697	0.428	0.494	0	1	1 if woman is married and in monogamous household
Polygamous union	5,697	0.393	0.488	0	1	1 if woman is married and in polygamous household
Household characteristics						
Age of household head	5,710	45.512	14.707	17	99	Age of household head in completed years
Sex of household head	5,710	0.954	0.209	0	1	1 if household head is male, 0 otherwise
HH literacy	5,710	0.252	0.434	0	1	1 if household head is literate
HH education years	5,710	1.453	4.488	0	16	Number of years of household head education
HH education level (ref.=no education)						
Primary education	5,710	0.078	0.269	0	1	1 if obtained primary education
Secondary education	5,710	0.018	0.133	0	1	1 if obtained secondary education
Household size	5,710	10.92	6.398	2	49	Number of household members
Under five children	5,710	3.080	2.111	0	17	Number of under five children in household
Number of plots	5,710	4.025	2.509	1	29	Number of household-owned plots
Improved seed	5,703	0.075	0.264	0	1	1 if household uses improved seed, 0 if local seed
Cultivated crops	5,698	0.751	0.432	0	1	1 if household produces only one crop, 0 otherwise
Crop number	5,710	4.914	3.189	1	29	Number of crops produced by household
Food expenditures	5,710	0.554	0.112	0.06	0.92	Share of food expenditures
Clean water	5,710	0.612	0.487	0	1	1 if household has access to clean water source
Sanitation	5,699	0.047	0.213	0	1	1 if household has access to sanitation
Poor	5,710	0.479	0.499	0	1	1 if household is poor
Child's individual characteristics						
Age (months)	5,710	29.004	16.039	0	59	Child age in months
Child under 2	5,710	0.385	0.486	0	1	1 if child is under 2 years old (23 months)
Child sex (female)	5,710	0.495	0.500	0	1	1 if child is female, 0 otherwise
Household child	5,710	0.819	0.384	0	1	1 if child is of household head
Growth programme	5,705	0.427	0.494	0	1	1 if child participates in growth programme
Nutrition programme	5,705	0.2113	0.409	0	1	1 if child participates in nutrition programme

Robustness check

Table A4: Empowerment indicators and child nutrition outcomes

Variable	HAZ (1)	WHZ (2)
Empowerment indicators		
Production	0.026	-0.018
	(0.057)	(0.049)
Land access	0.166*	0.106
	(0.097)	(0.086)
Access to credit	0.051	-0.202**
	(0.114)	(0.100)
Control over income	-0.087***	0.036
	(0.025)	(0.023)
Social group membership	0.150**	-0.049
	(0.062)	(0.055)
Child characteristics	Yes	Yes
Women characteristics	Yes	Yes
Household characteristics	Yes	Yes
Constant	1.673***	0.055
	(0.313)	(0.286)
Cluster	535	535
Observations	5,656	5,656
F	29.09	3.47
Prob>F	0.000	0.0000
R-squared	0.133	0.021

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1