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Impact of agricultural land ownership on child nutrition in rural Sudan: an investigation across gender

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Abstract

Purpose – In light of the inequality in access to farming land and the high prevalence of child malnutrition in Sudan, there is a lack of empirical research on the relationship between land ownership and child nutritional status. This study aims to examine the influence of agricultural landholding on the nutritional status of children under the age of five in rural Sudan.

Design/methodology/approach – The study utilizes data from Sudan's 2014 Multiple Indicator Cluster Survey (MICS), covering a sample of 10,753 rural children. The empirical analysis uses the two-stage least squares (2SLS) approach, adopting various estimation methods and model specifications for robustness check and comparison.

Findings – The results demonstrate that agricultural land has a positive and significant effect on reducing child malnutrition, signifying that children from families with agricultural land are less susceptible to malnutrition in Sudan. When examining the male and female sub-samples separately, the findings indicate a positive influence of land ownership on child malnutrition in the female sub-sample, while no significant impact is observed in the male sub-sample. This indicates a gender disparity in the effects of land ownership on child nutrition, with girls benefiting more from access to agricultural land compared to boys.

Originality/value – The study has several significant contributions. First, this is the sole study that examines the impact of agricultural land ownership on child malnutrition in Sudan. Second, considering the gender variations in nutritional status, investigating the influence of land ownership on child nutrition across genders addresses a significant gap in the current literature. Finally, the findings resulting from this study can contribute to achieving the United Nations Sustainable Development Goals (SDGs) to be achieved by 2030, precisely focusing on SDG2 Goal 2: Zero hunger and SDG 10: Goal 10: Reduced inequalities.

Keywords Land ownership, Child malnutrition, Children under-five years, Sudan

Paper type Research paper

1. Introduction

It is widely recognized that access to agricultural land plays a crucial role in reducing hunger and poverty, enhancing food security and improving the nutritional situation in impoverished agrarian communities (International Food Policy Research Institute [IFPRI], 2011; Siddiqui *et al.*, 2017). Land ownership facilitates agricultural production, leading to increased food availability and consumption, thereby improving the nutritional status of individuals within households. Conversely, unequal distribution of land among the population can have a detrimental impact on agricultural production, limiting access to food, particularly for children and consequently worsening their nutritional well-being.

JEL Classification — Q15, Q18, J13

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Therefore, land reform has gained significant and increasing attention from governments and international organizations as a pivotal factor in boosting the role of agriculture in ensuring food and nutrition security.

Like other countries in Africa, child malnutrition is prevalent in Sudan, especially in rural regions (Ebaidalla, 2021, 2023). Available statistics from the 2014 Multiple Indicator Cluster Survey (MICS) reveal a high prevalence of child malnutrition in Sudan. Approximately one-third (33%) of under-five children are underweight, around two in five children (38.2%) are stunted and one in six (16.3%) children under the age of five are wasted. The MICS (2014) also highlights a gender disparity in undernutrition, with male children slightly more affected by being underweight, stunted and wasted compared to their female counterparts. Furthermore, the report indicates regional disparities, with children residing in rural areas experiencing higher rates of being underweight and wasting (The United Nations Children's Fund, 2014; MICS, 2014).

Incidentally, the distribution of agricultural land among the rural Sudanese population is highly uneven. A small segment of the population owns the majority of the land, while the majority of poor households possess only small plots (Elhadary, 2010). This disparity can be attributed to the volatile land tenure system in the country, as most land acts implemented after the independence have deprived poor households of land access (Elhadary and Abdelatti, 2016). Additionally, over the past few decades, Sudan has experienced a significant wave of land grabbing by foreign countries, with the government allowing international companies to acquire land on an unprecedented scale (Babiker, 2013; Elhadary and Abdelatti, 2016). As a result, the uncertain and volatile land tenure system stands as a major constraint on agricultural productivity and food security in Sudan. Furthermore, the lack of land rights hampers the access of the majority of farmers to formal credit since land is often used as collateral (Ebaidalla, 2022). Hence, due to the limited access to land for rural households and the prevalence of child malnutrition in Sudan, there is a need to examine the impact of land ownership on child nutritional status. This issue has been largely overlooked by previous studies on child nutrition in the country.

Based on the above background, this study aims to investigate the influence of agricultural land ownership on the nutritional status of children under the age of five in Sudan [1]. Furthermore, it aims to explore whether the impact of landholding on child nutrition differs between male and female children. The study provides valuable and significant contributions. First, despite the high prevalence of child malnutrition and inequality in land access within rural areas, there is a severe lack of information regarding the role of land ownership in food and nutrition security in Sudan. Thus, the empirical findings resulting from this analysis will support efforts aimed at improving the nutritional status of children in rural Sudan. Second, considering the gender variations in nutrition among male and female children, investigating the impact of land ownership on child nutrition across genders will address a crucial gap in the existing literature. This will be particularly useful in designing appropriate policies to reduce gender disparities in rural areas. Finally, the study is timely, relevant, and consistent with the United Nations Sustainable Development Goals (SDGs) to be achieved by 2030. Specifically, it aligns with SDG2 (Goal 2: Zero Hunger) and SDG10 (Goal 10: Reduced Inequalities).

The remainder of this paper is organized as follows. Section 2 provides an overview of the conceptual framework and existing empirical literature regarding the relationship between agricultural landholding and child nutritional status. Section 3 describes the data and research methodology, followed by Section 4 which presents the empirical results and key findings. Finally, Section 5 concludes with some policy recommendations.

2. Conceptual framework and literature review

Extensive evidences indicate that access to land plays a crucial role in influencing nutritional status. Appendix A illustrates the pathways through which agricultural land ownership is

expected to affect child nutritional status. It is widely recognized that agricultural landholding incentivizes farmers to make investments in inputs, leading to increased land productivity, income generation, and ultimately impacting the nutritional well-being of household's members. Furthermore, land rights, often serving as collateral for credit, facilitate farmers' access to resources and adoption of advanced production technologies.

Appendix A depicts two distinct pathways through which landholding can influence a child's nutritional status. The first pathway highlights the direct link between households' access to land and agricultural production, which in turn, enhances food availability and consumption within the household, resulting in improved nutritional status among its members. Numerous empirical studies have demonstrated the positive impact of increased calorie intake on improving the nutritional status of young children (e.g. Tiwari *et al.*, 2013; Asfaw *et al.*, 2015).

The second pathway entails an indirect route through which agricultural landholding affects a child's nutritional status. It involves the premise that households' access to land rights leads to an increase in income through the sale of surplus production. Consequently, the increase in income enables households to allocate a larger portion of their resources toward purchasing high-calorie and protein-rich foods, eventually resulting in improved child nutritional status (IFPRI, 2011; Manda *et al.*, 2016). Essentially, the increase in agricultural production resulting from land access positively contributes to national income levels and improves access to healthcare and education, which are the main factors that influence child nutritional outcomes. Therefore, agricultural landholding improves child nutritional status by enhancing the economic and educational status of households. As indicated in the diagram, these two factors affect nutrition status through several channels including, purchasing power, nutritional behaviors and dietary diversity knowledge. It is worth mentioning that the two pathways work together and complement each other, making agricultural landholding a crucial factor in increasing food intake and, in turn, improving the nutritional status of households.

Numerous studies inspected the association between agricultural land ownership and food security (The World Bank, 2007; Gillespie *et al.*, 2019; Kadiyala *et al.*, 2011). For example, Rammohan and Pritchard (2014) demonstrate that land serves as a critical asset for rural families, with returns from land constituting a significant portion of their income. Landholding enables farmers to make income for both current expenditure and future investment. It also allows for the smoothing of consumption over time. Additionally, land ownership provides a means of protection against unforeseen events, such as health issues or severe weather conditions. Moreover, landholding is crucial in exerting control over many households' decisions, including crop selection, agricultural techniques, and choices regarding consumption and sale.

Siddiqui *et al.* (2017) examined the relationship between households" land ownership and the nutritional position of children in rural India. Their findings reveal that land has a significant role in ensuring food security and influencing the nutritional status of households. The study also indicates that households' ownership of agricultural land and their engagement in related activities directly and indirectly impact nutritional status. Moreover, children living in households with larger agricultural land sizes experience a more favorable situation in contrast to those in households with limited or negligible land ownership. Additionally, the study demonstrates that the proportion of children experiencing stunting and being underweight decreases as the size of households' agricultural landholdings increases in rural India.

Despite the growing acknowledgment of the associations between agricultural landholding and food security, there are two important observations regarding this relationship. First, it is worth noting that agricultural landholdings are not constantly immune from malnutrition, as average farm sizes have been steadily decreasing in several

less developed nations (Eastwood *et al.*, 2010; Rammohan and Pritchard, 2014), often falling below the minimum thresholds required for households to meet their provisioning needs. Consequently, these families may have to diversify their income beyond agriculture to cover their basic needs. Second, the diverse range of livelihood strategies among rural farmers implies varied responses to nutritional deprivation. However, a family's capability to overcome adverse economic crises relies on its capacity to effectively use its assets, which encompass the "five capitals": human, physical, social, financial and natural capital. This implies that households must leverage their available resources and adjust them to accommodate changing circumstances, enabling them to better manage and mitigate the impact of food insecurity.

The above discussion reveals that while a considerable body of research has focused on the link between agricultural landholding and child nutritional status in developing countries, there is a lack of empirical research dedicated to this issue in Sudan. Additionally, to the best of the authors' knowledge, no empirical study has investigated the impact of landholding on under-five children's nutritional status across genders. Therefore, this study addresses a significant gap in the existing literature and provides valuable policy recommendations to enhance land tenure and the health status of children under the age of five in Sudan.

3. Data and methodology

3.1 Data and variables

The data utilized in this study is obtained from the 2014 Sudanese MICS, a nationally representative household survey, implemented by the Central Bureau of Statistics (CBS) in Sudan. The survey encompasses a sample of 18,000 households, which includes approximately 14,751 children under the age of five. For our analysis, we focus on a sample of 10,753 children under the age of five, residing in rural Sudan.

The outcome variable is the nutritional status of children, which is measured by two anthropometric indicators: height-for-age (HAZ) and weight-for-age (WAZ) [2]. These indicators are assessed using standard deviation units (Z-scores) in comparison to the median of a benchmark population. The estimates rely on the international reference population suggested by the World Health Organization (WHO) (2006). Children are classified as stunted if their HAZ Z-score is more than −2 standard deviations below the median of the reference population. Likewise, those with a WAZ Z-score more than −2 standard deviations below the median are considered underweight. Therefore, our outcome variables are binary, taking a value of one if the HAZ and WAZ scores are less than −2 standard deviations for each nutritional category (i.e. stunted and underweight), and zero otherwise.

Our core explanatory variable is the agricultural landholding, which is a binary variable, indicating whether a household owns land for agricultural purposes. For the sake of comparison and validation, we also adopt land size measured in hectares as a key explanatory variable. Following the existing research on child nutrition (e.g. Musa *et al.*, 2014; Rashad and Sharaf, 2019), the control variables include child, household and parental characteristics, as well as other socioeconomic factors that are known to influence child nutrition. To account for regional differences, we use regional dummies in the analysis. The definition and summary statistics of the variables are presented in Appendix G [3].

3.2 Estimation strategy

Estimating the causal effect of agricultural landholding on child nutrition may confront the endogeneity problem, which requires an appropriate estimation method. That is,

landholding is potentially endogenous due to reverse causality, as households of undernourished children are less likely to own farming land. Therefore, the conventional regression methods such as probit, may result in biased estimators and only capture the simple correlation between landholding and children's nutritional status. Therefore, to address this methodological problem, the study adopts the instrumental variable (IV) estimation method.

3.2.1 The instrumental variable method (2SLS-IV). The IV estimation approach allows us to address potential endogeneity concerns by using IVs that are expected to be correlated with the treatment variable but not directly related to the dependent variable.

For the purpose of comparison, we initially estimate the probit equation as a baseline model without addressing the issue of endogeneity. Consistent with prior research on the factors influencing child nutritional status (e.g. Rashad and Sharaf, 2019; Musa *et al.*, 2014; Slavchevska, 2015), the basic probit model that captures the influence of landholding on nutritional outcomes can be formulated as follows:

$$\mathrm{P} = Pr\,(N_{ji} = 1|E) = \varphi\,(E'\gamma) \tag{1}$$

where N is a certain nutritional outcome (binary) variable understudy for child j born to household i. Pr is the probability, φ represents the cumulative distribution function (CDF) of the normal distribution, γ is a vector of unknown parameters, and E denotes the vector of explanatory variables, which involve control variables along with our key independent variable (i.e. landholding). However, the probit model may result in biased estimators due to potential endogeneity, as explained previously. Therefore, to address this methodological concern we adopt the two-stage least squares instrumental variable (2SLS-IV) estimation approach.

In the initial stage, we use a variable representing landholding as a linear function of a set of exogenous variables (such as control and IVs) and then apply its predicted value in the subsequent equation concerning nutritional status. Thus, the first equation in the form of 2SLS model can be set up as follows:

$$Land_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + v_i \tag{2}$$

$Land_i$ is the land holding, which is a function of exogenous variables (Z_1); instrumental variable (Z_2); and v_i is the disturbance term. The predicted value of $\widehat{Land_i}$ from Equations (2) enters Equation (3) below as a second-stage regression.

$$N_{ji} = \beta_0 + \beta_1 \widehat{Land_i} + \beta_1 X_{ji} + \varepsilon_i \tag{3}$$

3.2.2 Instrumental variables. Selecting an appropriate IV poses a significant challenge. The objective is to identify a variable that influences landholding without directly affecting the child's dietary health. To ensure the robustness of our analysis, we employ two IVs, namely the cluster/village average of land size and the ratio of land owners to non-owners in the cluster/village. The rationale behind utilizing these IVs is that they measure land market development and reflect the availability of landholding opportunities within the village/cluster. These variables serve as indicators of the effectiveness of the local land market. Thus, one can argue that residing in a village where a substantial proportion of farmers possess agricultural land would enhance the prospects of land ownership.

The validity of the IVs must be strongly correlated (*i.e.* $\alpha_2 \neq 0$) with the land size (e.g. endogenous variable) and exogenous in our main model. The validity of the instrument will be assessed using the Cragg–Donald test (Cragg and Donald, 1993) and the Wald F-test.

Furthermore, the cluster average of land size is likely to influence child nutrition solely through landholding, $Cov(Z_2, \varepsilon) = 0$ (i.e. exogenous), and has no autonomous impact on the child's nutritional status, as land ownership relies on economic circumstances.

To estimate our model, our primary analysis adopts two estimation techniques, namely the IV probit and bivariate probit (i.e. biprobit command in STATA). Since our two dependent variables (i.e. outcome and the potentially endogenous variable) are binary, the appropriate method of estimation is the bivariate probit model. However, using a bivariate probit model does not entail testing the validity of the instrument. Therefore, we adopt the IV probit estimation procedure to examine the first-stage results and assess whether the instruments are weak. The IV probit and biprobit methods allow us to account for the issue of endogeneity. The main difference between the two methods is that biprobit is used when both the dependent and endogenous variables are binary, while IV probit assumes that the endogenous covariate is continuous. Despite IV probit postulates a continuous endogenous regressor, the econometrics literature indicates that IV probit can still provide appropriate estimators (Angrist and Pischke, 2009). Furthermore, for the sake of comparison and sensitivity analysis, we estimate our model utilizing the 2SLS method (i.e. ivreg2 command in STATA) by treating both dependent and independent variables as continuous variables. In this approach, we proxy the dependent variable (child malnutrition) by the Z-score of anthropometric indicators (i.e. HAZ and WAZ), while the main explanatory variable (land ownership) is denoted by land size measured in the number of hectares.

4. Empirical results and discussion

This section presents the empirical findings and discussion. It is divided into two subsections. Subsection 4.1 outlines some descriptive statistics about agricultural land access and child nutritional status in rural Sudan. Subsection 4.2 reports the results of the IV estimation methods. Finally, Subsection 4.3 presents the results of the robustness analysis.

4.1 Descriptive statistics

4.1.1 Rural land market in rural Sudan. Appendix B illustrates the distribution of agricultural landholding by region in rural Sudan. The Appendix reveals that the majority of rural households in Khartoum lack access to farming land, as about 88% of the total rural population have no access to agricultural land. This can be explained by the observation that Khartoum is characterized by a higher level of urbanization and the agricultural land in this area is predominantly cultivated by a small portion of affluent farmers and companies. Appendix B also provides evidence that in regions, such as Kordofan and Darfur, the majority of households have access to farming land, as agriculture is the primary means of sustenance in these regions. In addition, Appendix B reflects a remarkable disparity in the distribution of agricultural land across regions in Sudan. We observe that about 52% of the rural population has access to farming land.

Regarding the distribution of agricultural land across wealth groups, Appendix C reports the decomposition of land ownership by wealth quintiles. The figure shows that the poorest and poor families have no access to agricultural land, while a large segment of the rich and richest groups have access to farming land. This implies that most agricultural land in rural Sudan is concentrated in the hands of rich families, indicating a high inequality in land distribution among wealth groups. These results seem consistent with the outcomes of many studies in the Sudanese literature (e.g. Elhadary, 2010; Elhadary and Abdelatti, 2016).

Appendix D presents the access to agricultural landholding by gender of the head of households. The Appendix points out that more than half of households headed by males possess agricultural land. This can be justified by the prevalence of the long-standing

predominant gender inequality in rural Sudan. This result probably also indicates some limitations on landholding for females in rural Sudan, which is consistent with many difficulties confronting women's land rights in many countries as explained in the international literature (see Allendorf, 2007).

4.1.2 Child nutrition situation in rural Sudan. To gain insights into the children's nutrition in rural Sudan, Appendix E provides a visual representation of three key nutritional indicators across different regions. The Appendix shows evidence of poor nutrition, as reflected by the prevalence of stunting, underweight and wasting. The Appendix also confirms that Khartoum and the Northern region have relatively minor rates of malnutrition. In line with expectations, the Eastern states exhibit the highest proportions of stunting and underweight children compared to other regions. Additionally, Darfur ranks second after the Eastern region in terms of the unfortunate nutritional situation faced by children. The high prevalence of malnutrition in the Eastern and Darfur regions can be attributed to the high levels of poverty and disparity prevalent in such areas.

Finally, Appendix F displays the child's nutritional status disaggregated by the child's sex in rural Sudan. The Appendix reveals that males are more likely to experience nutritional issues than girls. Specifically, boys demonstrate a higher prevalence of malnutrition across all indicators. This result is consistent with numerous previous studies carried out in Sub-Saharan Africa, including the research by Bukusuba *et al.* (2017) and Samuel *et al.* (2022), which have reported a higher incidence of stunting and wasting among boys compared to girls.

4.2 Econometrics results

As outlined in the methodology, we first employed the probit method as a baseline estimation. The estimation outcomes of the probit model presented in Table 1, demonstrate that the coefficients associated with land ownership exhibit a negative and statistically significant impact. This signifies that children residing in households that possess agricultural land are less prone to experiencing child malnutrition.

Given the potential endogeneity issue between landholding and child nutritional status, the study employed the IV probit and bivariate probit models. IVs utilized are the cluster/average of land size and the ratio of land owners to non-owners in a cluster/village. The estimation results of both IV probit and bivariate probit models of the entire sample of rural children (under five years) for HAZ and WAZ models are presented in Tables 1 and 2, respectively. The statistic of the Cragg–Donald test surpassed the typical threshold of 10 in all estimated models, thereby rejecting the weak instrument hypothesis. The Wald test statistic also rejects the null hypothesis that landholding is exogenous with a reasonable level of significance. This suggests that the land ownership variable is indeed endogenous, providing a valid rationale for utilizing the IV method. Furthermore, the outcomes of the first-stage regression in Appendix H show that the coefficients of instruments (i.e. cluster average of land size and the ratio of land owners to non-owners) are positive and significant, indicating a positive association between land ownership and our IVs [4].

The estimation results of IV probit and bivariate probit using the two IVs reveal that the impact of agricultural landholding is negative and significant on both HAZ and WAZ, suggesting that landholding reduces the likelihood of children being stunted and underweight. This also means that children of families who have access to farming land are less likely to experience stunting and underweight. This finding supports the findings of many previous empirical studies in the international literature (e.g. Allendorf, 2007; Menon *et al.*, 2014; Rammohan and Pritchard, 2014; Siddiqui *et al.*, 2017). The consistency of the results across different models implies the robustness of the findings and the appropriateness of IVs.

Variables	Probit Model 1	IV probit Model 1	IV probit Model 2	Biprobit Model 1	Biprobit Model 2
Land (cluster average)	−0.0161**	−0.0872***		−0.0761***	
	(0.0070)	(0.0292)		(0.0233)	
Land (cluster ratio)			−0.197**		−0.0649**
			(0.0896)		(0.0269)
Child age in month	−0.0101***	−0.0067***	−0.0104***	−0.0084***	−0.0103***
	(0.0007)	(0.00160)	(0.0007)	(0.00113)	(0.0007)
Male – child	0.0989***	0.0877***	0.102***	0.0997***	0.103***
	(0.0255)	(0.0288)	(0.0261)	(0.0251)	(0.0261)
Birth order of the child	0.00040	0.00933	−0.0015	0.00183	0.0003
	(0.00919)	(0.00934)	(0.0094)	(0.00836)	(0.0093)
Male – head	0.166***	0.0379	0.209***	0.0876**	0.190***
	(0.0479)	(0.0581)	(0.0503)	(0.0441)	(0.0498)
Household size	0.00823	−0.0313***	0.0123*	0.00738	0.00688
	(0.00611)	(0.0104)	(0.0064)	(0.00551)	(0.0062)
Mother age in years	−0.00039	−0.000366	−0.00042	−0.000945	−0.0002
	(0.00198)	(0.00191)	(0.0021)	(0.00178)	(0.0020)
Married – Mother	0.0687	0.102**	0.0603	0.0797*	0.0643**
	(0.0453)	(0.0437)	(0.0461)	(0.0413)	(0.0261)
Mother education – primary	−0.0456	−0.0538*	−0.0522	−0.0396	−0.0548
	(0.0325)	(0.0313)	(0.0333)	(0.0294)	(0.0334)
Mother education – secondary	−0.201***	−0.185***	−0.202***	−0.171***	−0.207***
	(0.0517)	(0.0533)	(0.0526)	(0.0506)	(0.0526)
Mother education – high	−0.369***	−0.344***	−0.346***	−0.286***	−0.355***
	(0.0902)	(0.0902)	(0.0910)	(0.0877)	(0.0913)
Father education – primary	−0.0461	−0.0193	−0.0572*	−0.0464	−0.0483
	(0.0325)	(0.0335)	(0.0333)	(0.0299)	(0.0332)
Father education – secondary	−0.0273	−0.0114	−0.0348	0.00269	−0.0304
	(0.0451)	(0.0441)	(0.0461)	(0.0413)	(0.0463)
Father education – high	−0.0334	−0.0391	−0.0478	−0.0129	−0.0491
	(0.0715)	(0.0696)	(0.0720)	(0.0656)	(0.0725)
Wealth	−0.0688***	−0.0779**	−0.0869***	−0.0601***	−0.0749***
	(0.0198)	(0.0367)	(0.0209)	(0.0180)	(0.0203)
Toilet	0.0327	−0.0822*	0.0463	0.0391	0.0313
	(0.0380)	(0.0463)	(0.0387)	(0.0351)	(0.0383)
Water	0.0306	−0.0847**	0.0245	0.0208	0.0343
	(0.0421)	(0.0410)	(0.0427)	(0.0371)	(0.0425)
Central	0.252**	−0.241	0.299**	0.124	0.253**
	(0.115)	(0.152)	(0.117)	(0.113)	(0.115)
Northern	−0.0411	−0.405***	0.0006	−0.147	−0.0350
	(0.120)	(0.128)	(0.121)	(0.118)	(0.120)
Eastern	0.271**	−0.164	0.312**	0.170	0.266**
	(0.121)	(0.151)	(0.122)	(0.117)	(0.121)
Kordufan	−0.107	−0.574***	−0.0509	−0.181	−0.1122
	(0.121)	(0.137)	(0.124)	(0.118)	(0.121)
Darfur	−0.117	−0.855***	−0.0228	−0.309***	−0.0920
	(0.121)	(0.152)	(0.125)	(0.118)	(0.121)
First-stage partial R^2		0.055	0.054		
Wald test of exogeneity		10.5 (0.001)	6.2 (0.012)		
Cragg–Donald test F-statistic		43.2 (0.000)	1035.2 (0.00)		
Likelihood-ratio test of rho = 0				11.9 (0.000)	4.02 (0.044)
Pseudo R^2	0.345				
Observations	10,753	10,753	10,753	10,753	10,753

Note(s): Standard errors in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$
Standard errors clustered at the village/cluster level
"Land (cluster average)" denotes that the land variable is instrumented by the cluster average of land size, while "Land (cluster ratio)" is instrumented by the ratio of land owners to non-owners
Source(s): Author's own work

Table 1. Results of IV probit and bivariate probit (HAZ): full sample – marginal effects

Variables	Probit	IV probit Model 1	IV probit Model 2	Biprobit Model 1	Biprobit Model 2
Land (cluster average)	−0.0311*	−0.0429**		−0.0945***	
	(0.0184)	(0.0208)		(0.0245)	
Land (cluster ratio)			−0.0361*		−0.0690**
			(0.0197)		(0.0267)
Child age in month	−0.0075***	−0.0048***	−0.0076***	−0.0063***	0.0077***
	(0.0007)	(0.00131)	(0.0007)	(0.00092)	(0.0008)
Male – child	0.0652**	0.0587**	0.0726***	0.0674***	0.0729***
	(0.0259)	(0.0267)	(0.0265)	(0.0248)	(0.0267)
Birth order of the child	0.0202**	0.0281***	0.0232**	0.0203**	0.0224**
	(0.00935)	(0.00908)	(0.0095)	(0.00894)	(0.0097)
Male – head	0.210***	0.0121	0.226***	0.146***	0.230***
	(0.0492)	(0.0651)	(0.0519)	(0.0476)	(0.0512)
Household size	0.00452	−0.0432***	−0.0064	−0.00734	−0.0048
	(0.00626)	(0.00895)	(0.0066)	(0.00584)	(0.0063)
Mother age in years	−0.00119	−0.000741	−0.0006	−0.00135	−0.0007
	(0.00202)	(0.00194)	(0.0020)	(0.00187)	(0.00206)
Married – Mother	0.0479	0.0740*	0.0456	0.0477	0.0448
	(0.0462)	(0.0441)	(0.0471)	(0.0432)	(0.0476)
Mother education – primary	−0.0493	−0.0611*	−0.0626*	−0.0489	−0.0615*
	(0.0330)	(0.0318)	(0.0338)	(0.0309)	(0.0342)
Mother education – secondary	−0.202***	−0.192***	−0.209***	−0.186***	−0.211***
	(0.0528)	(0.0545)	(0.0537)	(0.0518)	(0.0550)
Mother education – high	−0.326***	−0.304***	−0.316***	−0.251***	−0.312***
	(0.0922)	(0.0898)	(0.0931)	(0.0892)	(0.0941)
Father education – primary	0.0263	0.0351	0.0208	0.0168	0.0181
	(0.0329)	(0.0317)	(0.0338)	(0.0307)	(0.0339)
Father education – secondary	−0.0570	−0.0595	−0.0537	−0.0543	−0.0541
	(0.0459)	(0.0452)	(0.0471)	(0.0441)	(0.0475)
Father education – high	−0.142*	−0.118	−0.157**	−0.108	−0.156**
	(0.0745)	(0.0728)	(0.0752)	(0.0715)	(0.0753)
Wealth	−0.0847***	−0.0651*	−0.0829***	−0.0726***	−0.0833***
	(0.0201)	(0.0394)	(0.0214)	(0.0189)	(0.0206)
Toilet	0.0409	−0.0832*	0.0291	0.0358	0.0325
	(0.0387)	(0.0470)	(0.0396)	(0.0370)	(0.0390)
Water	0.0696	−0.118***	−0.0788*	0.0623	−0.0773*
	(0.0426)	(0.0404)	(0.0432)	(0.0391)	(0.0430)
Central	0.0580	−0.396***	0.0380	−0.0629	0.0468
	(0.115)	(0.138)	(0.117)	(0.116)	(0.115)
Northern	0.0605	−0.293**	0.0517	−0.0230	0.0573
	(0.120)	(0.135)	(0.121)	(0.120)	(0.120)
Eastern	0.0978	−0.298**	0.0743	0.00694	0.0858
	(0.121)	(0.140)	(0.123)	(0.120)	(0.121)
Kordufan	−0.208*	−0.664***	−0.238*	−0.299**	−0.228*
	(0.121)	(0.132)	(0.124)	(0.123)	(0.121)
Darfur	−0.171	−0.861***	−0.177	−0.331***	−0.169
	(0.121)	(0.154)	(0.125)	(0.122)	(0.121)
First-stage partial R^2		0.099	0.095		
Wald test of exogeneity		7.1 (0.007)	2.19 (0.138)		
Cragg–Donald test F-statistic		43.27 (0.00)	1035.2 (0.00)		
Likelihood-ratio test of rho = 0				10.0 (0.001)	4.56 (0.032)
Pseudo R^2	0.425				
Observations	10,753	10,753	10,753	10,753	10,753

Note(s): Standard errors in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$
Standard errors clustered at the village level
"Land (cluster average)" denotes that the land variable is instrumented by the cluster average of land size, while "Land (cluster ratio)" is instrumented by the ratio of land owners to non-owners
Source(s): Author's own work

Table 2.
Results of IV probit and bivariate probit (WAZ): full sample – marginal effects

Moreover, the results of the probit, IV probit and bivariate probit model for both HAZ and WAZ indicate that the majority of the control variables bear their expected signs. For example, the coefficient for child sex is positive and statistically significant, suggesting that male children are more prone to the risk of stunting and underweight compared to their female counterparts. Children belonging to households headed by males are more likely to face stunting and underweight issues. These findings highlight the significance of gender in child nutrition in Sudan. As anticipated, the influence of maternal and paternal education is negative and significant across all educational levels, particularly for mothers, indicating that children with educated parents have fewer chances of experiencing nutritional problems. These results are consistent with previous studies conducted by Kabubo-Mariara *et al.* (2009) and Rashad and Sharaf (2019). Furthermore, the coefficients of the wealth variable in all HAZ and WAZ models are negative and significant, implying that children from affluent families are less likely to experience poor nutritional status.

To examine whether the impact of landholding on nutritional status varies by gender of the child, we conducted separate estimations for boy and girl sub-samples. The results of both IV probit and bivariate probit for HAZ and WAZ are presented in Tables 3 and 4, respectively. Consistent with the findings of the full sample, the analysis of the female sample using both IV probit and bivariate probit models reveals that access to agricultural land has a negative impact on stunting and underweight. This suggests that girls under the age of five, whose households have access to farming land, are less likely to experience malnutrition. Surprisingly, the influence of landholding has no significant impact on the nutritional status of boys under the age of five, implying that agricultural land does not play a significant role in improving the nutritional status of male children. This result can be attributed to differences in food consumption, dietary patterns and preferences between boys and girls in rural Sudan (Abdalla *et al.*, 2009; Alredaisy *et al.*, 2012; Khalid *et al.*, 2017). Therefore, the analysis indicates a notable gender disparity in the impact of farming land on the nutritional status of children under the age of five in Sudan.

4.2.1 Robustness analysis. To ensure the robustness of our analysis, we estimated the model using land size measured by the number of hectares as a key independent variable. The estimation results of IV probit for both male and female sub-samples are reported in Table 5. The results display that the parameter of land size is negative and significant in female models, whereas its impact is not significant in the male models. This finding confirms the results reported in Tables 1 and 2. Regarding the control variables, the results reveal that most of the estimated coefficients bear their expected signs and align with the previous analyses.

Furthermore, to assess whether the impact of land ownership on child nutrition varies based on the nature of the nutritional variable, we re-estimated the model using child nutrition as a continuous variable (i.e. standard deviation of Z-scores relative to the median of a reference population). Since the anthropometric indicator is a continuous variable, we estimated the model using the 2SLS model with the cluster average of land size and the ratio of land owners to non-owners as IVs [5]. The estimation results of 2SLS in Table 6 indicate that the impact of land ownership is negative and significant for the female group. Whereas for the male group, the effect of land ownership is found to be insignificant, supporting the results of previous analyses.

Overall, the results for IV probit and biprobit methods for both HAZ and WAZ indicators under the two IVs suggest that land ownership has a negative and significant effect on child malnutrition among children under the age of five. The results also are robust across different model specifications and measurements of land holding and child nutrition. This implies that families who have access to agricultural land are better equipped to provide nutritious food and prevent food shortages among their members. Regarding the gendered impact of landholding on nutritional status, our findings indicate that the effect of

Table 3.
Results of IV probit and bivariate probit: male and female sample – marginal effects

The dependent variable is the nutrition status (HAZ) – (binary variable)								
	IV probit				Biprobit			
	Male sample		Female sample		Male sample		Female sample	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Land (average)	−0.0630		−0.0933***		−0.0345		−0.1463**	
	(0.135)		(0.0347)		(0.0923)		(0.0710)	
Land (ratio)		−0.130		−0.245*		−0.161		−0.261*
		(0.127)		(0.133)		(0.152)		(0.147)
Child age in month	−0.00389**	−0.0075***	−0.0097***	0.0138***	−0.00612***	−0.0192***	−0.0106***	−0.0134***
	(0.00194)	(0.0011)	(0.0024)	(0.00112)	(0.00129)	(0.0021)	(0.00236)	(0.0011)
Birth order of the child	0.0106	−0.00516	0.0106	0.00517	0.00495	−0.0089	0.00384	0.00643
	(0.0130)	(0.0130)	(0.0133)	(0.0133)	(0.0115)	(0.00765)	(0.0119)	(0.0136)
Male – head	−0.0280	0.169**	−0.0386	0.242***	0.0538	0.0959***	0.115*	0.225***
	(0.0700)	(0.0716)	(0.0963)	(0.0712)	(0.0611)	(0.0231)	(0.0632)	(0.0702)
Household size	−0.0317**	−0.0213**	−0.0351***	0.0015	−0.0168**	0.0250***	−0.00461	−0.0023
	(0.0157)	(0.00900)	(0.0128)	(0.0094)	(0.00773)	(0.0030)	(0.00803)	(0.0091)
Mother age	6.71e-05	−0.000240	−0.000342	−0.00065	−0.00155	−9.59e-05	4.25e-05	−0.0007
	(0.00266)	(0.00284)	(0.00277)	(0.0028)	(0.00245)	(0.0009)	(0.00251)	(0.0029)
Married – Mother	0.101*	0.0392	0.106	0.0770	0.0632	0.00371	0.0912	0.0780
	(0.0591)	(0.0644)	(0.0650)	(0.0667)	(0.0559)	(0.0224)	(0.0608)	(0.0663)
Mother – primary	−0.134***	−0.123***	0.0339	0.0152	−0.112***	−0.0309**	0.0319	0.0162
	(0.0453)	(0.0468)	(0.0464)	(0.0481)	(0.0427)	(0.0134)	(0.0424)	(0.0479)
Mother – secondary	−0.252***	−0.302***	−0.109	−0.0945	−0.221***	−0.0208	−0.114	−0.0919
	(0.0762)	(0.0743)	(0.0771)	(0.0753)	(0.0723)	(0.0253)	(0.0708)	(0.0754)
Mother – high	−0.483***	−0.640***	−0.178	−0.0905	−0.508***	0.0105	−0.0797	−0.0949
	(0.160)	(0.139)	(0.123)	(0.120)	(0.139)	(0.0403)	(0.112)	(0.122)
Father – primary	0.0182	−0.0395	−0.0602	−0.0653	−0.00548	−0.0402**	−0.0842*	−0.0583
	(0.0431)	(0.0466)	(0.0523)	(0.0479)	(0.0400)	(0.0163)	(0.0463)	(0.0477)
Father – secondary	0.00187	−0.0288	−0.0260	−0.0255	0.0310	−0.0201	−0.0202	−0.0217
	(0.0621)	(0.0654)	(0.0635)	(0.0657)	(0.0577)	(0.0222)	(0.0579)	(0.0655)
Father – high	−0.0472	−0.0685	−0.0208	−0.0211	−0.0393	0.0199	0.0144	−0.0238
	(0.0955)	(0.102)	(0.102)	(0.103)	(0.0910)	(0.0345)	(0.0918)	(0.102)

(*continued*)

Table 3.

The dependent variable is the nutrition status (HAZ) – (binary variable)

	IV probit				Biprobit			
	Male sample		Female sample		Male sample		Female sample	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Wealth	−0.110**	−0.0840***	0.0467	−0.0944***	−0.0559**	−0.0374***	−0.0678***	−0.0866***
	(0.0496)	(0.0297)	(0.0524)	(0.0298)	(0.0245)	(0.0098)	(0.0263)	(0.0292)
Toilet	−0.104	0.0645	−0.0701	0.0268	0.0564	0.0669	0.0206	0.0165
	(0.0673)	(0.0543)	(0.0626)	(0.0555)	(0.0487)	(0.0787)	(0.0495)	(0.0550)
Water	0.0812	−0.0172	−0.101*	0.0677	−0.0147	−0.0232	0.0640	0.0735
	(0.0584)	(0.0593)	(0.0590)	(0.0620)	(0.0504)	(0.0212)	(0.0540)	(0.0618)
Central	−0.340	0.325*	−0.165	0.260	0.108	0.199***	0.135	0.226
	(0.210)	(0.169)	(0.214)	(0.163)	(0.160)	(0.0533)	(0.157)	(0.161)
Northern	−0.558***	0.0136	−0.259	−0.00888	−0.186	0.106*	−0.0973	−0.0270
	(0.179)	(0.175)	(0.180)	(0.170)	(0.164)	(0.0558)	(0.166)	(0.169)
Eastern	−0.310	0.247	−0.0202	0.374**	0.0698	0.218***	0.274*	0.339**
	(0.199)	(0.176)	(0.226)	(0.171)	(0.163)	(0.0566)	(0.165)	(0.169)
Kordufan	−0.711***	−0.0912	−0.449**	−0.0249	−0.252	−0.280***	−0.107	−0.0709
	(0.184)	(0.179)	(0.202)	(0.174)	(0.166)	(0.0564)	(0.167)	(0.170)
Darfur	−0.972***	−0.0715	−0.750***	0.0111	−0.367**	−0.305***	−0.249	−0.0443
	(0.195)	(0.180)	(0.231)	(0.175)	(0.167)	(0.0562)	(0.169)	(0.170)
First-stage partial R^2	0.046	0.044	0.093	0.091				
Wald test	6.4 (0.011)	4.7 (028)	4.5 (0.033)	1.76 (0.184)				
Cragg–Donald test *F*-statistic	18.5 (0.000)	507.9 (0.000)	24.8 (0.000)	521.4 (0.000)				
Likelihood-ratio test					4.9 (0.025)	3.2 (0.070)	2.3 (0.182)	0.79 (0.372)
Observations	5,438	5,438	5,315	5,315	5,438	5,438	5,315	5,315

Note(s): Standard errors in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$
Standard errors clustered at the village/cluster level
"Land (cluster average)" denotes that the land variable is instrumented by the cluster average of land size, while "Land (cluster ratio)" is instrumented by the ratio of land owners to non-owners
Source(s): Author's own work

Table 4.
Results of IV probit and bivariate probit: male and female sample – marginal effects

The dependent variable is the nutrition status (WAZ) – (binary variable)								
	IV probit				Biprobit			
	Male sample		Female sample		Male sample		Female sample	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Land (average)	−0.0332		−0.0982***		−0.0754		−0.1626**	
	(0.0571)		(0.0311)		(0.632)		(0.078)	
Land (ratio)		−0.112		0.173*		0.0117		0.130**
		(0.129)		(0.094)		(0.0921)		(0.055)
Child age in month	−0.00336*	0.0065***	−0.00631***	−0.0089***	−0.0052***	−0.0064***	−0.0073***	−0.1301***
	(0.00182)	(0.0011)	(0.00181)	(0.0011)	(0.00131)	(0.0011)	(0.00134)	(0.0199)
Birth order of the child	0.0345***	0.0227*	0.0194	0.0224	0.0245**	0.0238*	0.0142	0.0089***
	(0.0125)	(0.0133)	(0.0134)	(0.0137)	(0.0117)	(0.0133)	(0.0133)	(0.00114)
Male – head	−0.0164	0.148**	0.0655	0.294***	0.0646	0.138*	0.227***	0.0199
	(0.0725)	(0.0729)	(0.116)	(0.0742)	(0.0613)	(0.0724)	(0.0713)	(0.0136)
Household size	−0.0529***	−0.00460	−0.0315**	−0.0068	−0.0104	−0.00784	−0.00311	0.317***
	(0.0111)	(0.00932)	(0.0140)	(0.0095)	(0.00751)	(0.00881)	(0.00884)	(0.0726)
Mother age	−0.00198	−0.00276	0.000970	0.00120	−0.00399	−0.00254	0.00156	−0.0003
	(0.00288)	(0.00290)	(0.00287)	(0.0029)	(0.00246)	(0.00289)	(0.00279)	(0.0091)
Married – Mother	0.106*	0.0847	0.0436	0.0017	0.0669	0.0882	0.0278	0.0012
	(0.0601)	(0.0662)	(0.0652)	(0.0671)	(0.0557)	(0.0662)	(0.0646)	(0.0029)
Mother – primary	−0.135***	−0.138***	0.0217	0.0153	−0.109**	−0.141***	0.0220	0.0027
	(0.0458)	(0.0477)	(0.0469)	(0.0482)	(0.0435)	(0.0476)	(0.0460)	(0.0670)
Mother – secondary	−0.221***	−0.244***	−0.169**	−0.164**	−0.179**	−0.251***	−0.189**	0.0157
	(0.0732)	(0.0757)	(0.0833)	(0.0770)	(0.0706)	(0.0754)	(0.0771)	(0.0481)
Mother – high	−0.277**	−0.353***	−0.316**	−0.281**	−0.245**	−0.360***	−0.249*	−0.168**
	(0.129)	(0.136)	(0.128)	(0.128)	(0.121)	(0.136)	(0.129)	(0.0768)
Father – primary	0.0690	0.0671	−0.00914	−0.0242	0.0569	0.0721	−0.0324	−0.275**
	(0.0435)	(0.0474)	(0.0489)	(0.0483)	(0.0400)	(0.0472)	(0.0463)	(0.128)
Father – secondary	−0.0465	−0.0524	−0.0845	−0.0561	−0.0281	−0.0488	−0.0881	−0.0342
	(0.0623)	(0.0669)	(0.0664)	(0.0663)	(0.0580)	(0.0669)	(0.0649)	(0.0479)
Father – high	−0.144	−0.246**	−0.0690	−0.0671	−0.147	−0.245**	−0.0453	−0.0600
	(0.105)	(0.108)	(0.105)	(0.105)	(0.0992)	(0.108)	(0.104)	(0.0661)

(*continued*)

Table 4.

The dependent variable is the nutrition status (WAZ) – (binary variable)

	IV probit				Biprobit			
	Male sample		Female sample		Male sample		Female sample	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Wealth	−0.0937*	−0.0965***	0.0366	−0.0751**	−0.0720***	−0.0858***	−0.0726***	−0.0600
	(0.0548)	(0.0304)	(0.0557)	(0.0303)	(0.0254)	(0.0289)	(0.0281)	(0.105)
Toilet	−0.102	0.0691	−0.0680	−0.00745	0.0555	0.0586	0.0162	−0.0822***
	(0.0687)	(0.0554)	(0.0648)	(0.0564)	(0.0483)	(0.0546)	(0.0553)	(0.0294)
Water	−0.143***	0.0798	0.0951	0.0768	0.0624	0.0876	0.0627	0.0063
	(0.0542)	(0.0600)	(0.0604)	(0.0626)	(0.0504)	(0.0596)	(0.0592)	(0.0558)
Central	−0.521***	−0.0152	−0.269	0.0975	−0.121	−0.0487	0.00448	0.0713
	(0.183)	(0.165)	(0.208)	(0.167)	(0.153)	(0.162)	(0.171)	(0.0623)
Northern	−0.503***	−0.0300	−0.0806	0.163	−0.114	−0.0609	0.0854	0.140
	(0.184)	(0.170)	(0.196)	(0.173)	(0.158)	(0.168)	(0.178)	(0.165)
Eastern	−0.419**	0.0158	−0.177	0.130	−0.0718	−0.0127	0.0871	0.182
	(0.185)	(0.172)	(0.212)	(0.176)	(0.157)	(0.170)	(0.178)	(0.172)
Kordufan	−0.813***	−0.305*	−0.510**	−0.167	−0.369**	−0.347**	−0.209	0.182
	(0.176)	(0.176)	(0.203)	(0.178)	(0.169)	(0.171)	(0.179)	(0.173)
Darfur	−1.011***	−0.256	−0.696***	−0.0964	−0.412**	−0.303*	−0.233	−0.113
	(0.191)	(0.177)	(0.250)	(0.179)	(0.166)	(0.171)	(0.178)	(0.174)
First-stage partial R^2	0.045	0.043	0.096	0.090				
Wald test of	6.0(0.014)	1.1 (0.290)	3.6 (0.055)	3.6 (0.057)				
Cragg–Donald test	18.5 (0.000)	507.9 (0.000)	24.8 (0.000)	521.4 (0.000)				
Likelihood-ratio test					3.5 (0.059)	3.5 (0.060)	2.9 (0.084)	0.6 (0.429)
Observations	5,438	5,438	5,315	5,315	5,438	5,438	5,315	5,315

Note(s): Standard errors in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Standard errors clustered at the village/cluster level

"Land (cluster average)" denotes that the land variable is instrumented by the cluster average of land size, while "Land (cluster ratio)" is instrumented by the ratio of land owners to non-owners

Source(s): Author's own work

Table 5.
Results of IV probit estimation for male and female sample – marginal effects

The dependent variable is the nutrition status (HAZ and WAZ) - (binary variable)

	HAZ				WAZ			
	Male sample		Female sample		Male sample		Female sample	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Land (average)	−0.0815		−0.0076**		−0.0790		−0.0077**	
	(0.308)		(0.00355)		(0.312)		(0.0036)	
Land (ratio)		−0.0113		−0.0156**		−0.0111		−0.0171*
		(0.0108)		(0.0064)		(0.0085)		(0.0093)
Child age in month	−0.0074***	−0.0073***	−0.0126***	−0.0130***	−0.0064***	−0.0064***	−0.0079***	−0.0088***
	(0.0011)	(0.0011)	(0.0012)	(0.00129)	(0.0011)	(0.00111)	(0.0012)	(0.0011)
Birth order of the child	0.0098	−0.0059	0.0012	0.00120	0.0262*	0.0221*	0.0130	0.0261*
	(0.0137)	(0.0129)	(0.0144)	(0.0140)	(0.0141)	(0.0134)	(0.0146)	(0.0138)
Male – head	0.0666	0.147**	0.137*	0.234***	0.0810	0.138*	0.244***	0.290***
	(0.072)	(0.0705)	(0.0722)	(0.0693)	(0.0736)	(0.0722)	(0.0746)	(0.0754)
Household size	−0.0270***	−0.0243**	0.0003	−0.00736	−0.00607	−0.00290	0.000982	−0.0131
	(0.0091)	(0.0094)	(0.0099)	(0.0115)	(0.00950)	(0.0102)	(0.0101)	(0.0113)
Mother age	−0.0018	−0.0002	−0.0003	−0.00139	−0.00482	−0.00278	0.00126	0.00197
	(0.0029)	(0.0028)	(0.00303)	(0.00291)	(0.00301)	(0.00289)	(0.00307)	(0.00294)
Married – Mother	0.0669	0.0526	0.111	0.0803	0.0754	0.0913	0.0331	−0.00349
	(0.0673)	(0.0638)	(0.0701)	(0.0656)	(0.0688)	(0.0660)	(0.0708)	(0.0664)
Mother – primary	−0.124**	−0.114**	0.0418	0.0205	−0.124**	−0.133***	0.0257	0.00928
	(0.0485)	(0.0474)	(0.0501)	(0.0474)	(0.0494)	(0.0483)	(0.0504)	(0.0479)
Mother – secondary	−0.246***	−0.281***	−0.130	−0.0713	−0.198**	−0.236***	−0.199**	−0.182**
	(0.0777)	(0.0767)	(0.0805)	(0.0765)	(0.0792)	(0.0774)	(0.0822)	(0.0764)
Mother – high	−0.592***	−0.619***	−0.0650	−0.0546	−0.280*	−0.348**	−0.244*	−0.309**
	(0.147)	(0.140)	(0.134)	(0.125)	(0.143)	(0.136)	(0.140)	(0.128)
Father – primary	−0.0160	−0.0391	−0.103**	−0.0562	0.0603	0.0666	−0.0347	−0.0321
	(0.0481)	(0.0462)	(0.0505)	(0.0472)	(0.0489)	(0.0474)	(0.0507)	(0.0475)
Father – secondary	0.0395	−0.0113	−0.0200	−0.00917	−0.0336	−0.0436	−0.0920	−0.0716
	(0.0697)	(0.0651)	(0.0694)	(0.0655)	(0.0713)	(0.0670)	(0.0705)	(0.0658)
Father – high	−0.0243	−0.0250	0.00906	−0.0199	−0.169	−0.223**	−0.0533	−0.0663
	(0.110)	(0.104)	(0.111)	(0.101)	(0.114)	(0.111)	(0.114)	(0.104)

(*continued*)

Table 5.

The dependent variable is the nutrition status (HAZ and WAZ) - (binary variable)

	HAZ				WAZ			
	Male sample		Female sample		Male sample		Female sample	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Wealth	−0.0751**	−0.0909***	−0.0823***	−0.107***	−0.0952***	−0.100***	−0.0801**	−0.0580
	(0.0298)	(0.0305)	(0.0311)	(0.0323)	(0.0303)	(0.0319)	(0.0313)	(0.0358)
Toilet	0.0861	0.0720	0.0302	0.0365	0.0843	0.0731	0.0217	−0.0189
	(0.0588)	(0.0545)	(0.0600)	(0.0565)	(0.0599)	(0.0562)	(0.0610)	(0.0574)
Water	−0.0327	−0.0229	0.0646	0.0687	0.0614	0.0764	0.0610	0.0728
	(0.0607)	(0.0592)	(0.0641)	(0.0614)	(0.0613)	(0.0606)	(0.0648)	(0.0618)
Central	0.182	0.295*	0.218	0.266*	−0.0992	−0.0269	0.0487	0.0816
	(0.189)	(0.165)	(0.184)	(0.161)	(0.187)	(0.163)	(0.186)	(0.168)
Northern	−0.196	−0.0201	−0.0700	0.0173	−0.121	−0.0465	0.130	0.131
	(0.195)	(0.171)	(0.194)	(0.171)	(0.192)	(0.167)	(0.194)	(0.175)
Eastern	0.120	0.232	0.399**	0.450**	−0.0528	0.0105	0.159	0.0361
	(0.195)	(0.173)	(0.194)	(0.185)	(0.193)	(0.171)	(0.197)	(0.196)
Kordufan	−0.234	−0.108	−0.0552	0.0125	−0.394**	−0.312*	−0.171	−0.203
	(0.196)	(0.176)	(0.193)	(0.181)	(0.194)	(0.174)	(0.195)	(0.182)
Darfur	−0.387**	−0.175	−0.226	−0.0285	−0.455**	−0.307*	−0.214	−0.0516
	(0.196)	(0.173)	(0.191)	(0.168)	(0.194)	(0.170)	(0.193)	(0.171)
First-stage partial R^2	0.111	0.091	0.106	0.084	0.114	0.093	0.103	0.087
Wald test	8.1 (0.004)	3.6 (0.056)	4.35 (0.036)	1.7 (0.185)	7.0 (0.008)	0.8 (0.357)	2.9 (0.083)	2.1 (0.147)
Observations	5,438	5,438	5,315	5,315	5,438	5,438	5,315	5,315

Note(s): Standard errors in parentheses; *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$
Standard errors clustered at the village/cluster level
The key independent variable (i.e. land) is a continuous variable, measured in the number of hectares
Land (cluster average) denotes that the land variable is instrumented by the cluster average of land size, while Land (cluster ratio) is instrumented by the ratio of land owners to non-owners
Source(s): Author's own work

Table 6. Results of 2SLS estimation for male and female sample

The dependent variable is the nutrition status (HAZ and WAZ) (continuous variable)

	HAZ				WAZ			
	Male sample		Female sample		Male sample		Female sample	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Land (average)	0.0497		−0.0507***		−0.0491		−0.0512***	
	(0.0967)		(0.0107)		(0.0924)		(0.0103)	
Land (ratio)		0.0023		0.0192**		−0.0283		0.0233*
		(0.0190)		(0.0077)		(0.0183)		(0.0137)
Child age in month	−0.0083**	−0.0099***	−0.0164***	−0.0151***	−0.0175***	−0.0162***	−0.0265***	−0.0230***
	(0.0035)	(0.0032)	(0.0035)	(0.0032)	(0.00336)	(0.0031)	(0.00338)	(0.00308)
Birth order of the child	0.108**	0.108***	0.0271	−0.0178	0.0897**	0.0872**	0.0509	0.00525
	(0.0430)	(0.0392)	(0.0432)	(0.0406)	(0.0411)	(0.0378)	(0.0417)	(0.0389)
Male – head	−0.585***	−0.802***	−0.553***	−0.806***	−0.530**	−0.757***	−0.754***	−0.975***
	(0.222)	(0.207)	(0.209)	(0.198)	(0.212)	(0.199)	(0.202)	(0.189)
Household size	−0.102***	−0.0491*	−0.0316	−0.0081	−0.0952***	−0.0196	−0.0535*	−0.0219
	(0.028)	(0.0294)	(0.0295)	(0.0337)	(0.0273)	(0.0284)	(0.0285)	(0.0322)
Mother age	−0.0069	−0.0158*	−0.0103	−0.0130	−0.00821	−0.0194**	−0.00763	−0.0110
	(0.0091)	(0.0084)	(0.0090)	(0.0084)	(0.00877)	(0.00812)	(0.00870)	(0.00807)
Married – Mother	−0.0044	0.112	0.0201	0.112	−0.00508	0.138	0.0406	0.166
	(0.208)	(0.190)	(0.206)	(0.189)	(0.198)	(0.184)	(0.199)	(0.181)
Mother – primary	−0.0550	−0.0999	−0.435***	−0.406***	−0.0538	−0.0381	−0.472***	−0.475***
	(0.151)	(0.141)	(0.150)	(0.138)	(0.144)	(0.136)	(0.145)	(0.133)
Mother – secondary	−0.138	0.0656	−0.532**	−0.602***	−0.435*	−0.0823	−0.475**	−0.529**
	(0.236)	(0.219)	(0.235)	(0.218)	(0.226)	(0.211)	(0.227)	(0.208)
Mother – high	0.119	0.153	−0.851**	−0.814**	−0.470	−0.230	−1.012***	−0.909***
	(0.414)	(0.371)	(0.392)	(0.351)	(0.396)	(0.358)	(0.378)	(0.336)
Father – primary	−0.358**	−0.415***	−0.102	−0.278**	−0.412***	−0.494***	−0.0760	−0.197
	(0.150)	(0.139)	(0.151)	(0.137)	(0.143)	(0.134)	(0.145)	(0.132)
Father – secondary	−0.307	−0.417**	−0.437**	−0.537***	−0.249	−0.318*	−0.420**	−0.466***
	(0.216)	(0.194)	(0.206)	(0.189)	(0.206)	(0.187)	(0.199)	(0.181)
Father – high	−0.712**	−0.396	−0.149	−0.142	−0.558*	−0.117	−0.274	−0.219
	(0.334)	(0.305)	(0.331)	(0.291)	(0.319)	(0.294)	(0.319)	(0.278)

(*continued*)

Table 6.

The dependent variable is the nutrition status (HAZ and WAZ) (continuous variable)

	HAZ				WAZ			
	Male sample		Female sample		Male sample		Female sample	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Wealth	−0.118	0.0546	−0.0253	−0.0141	−0.114	−0.0413	−0.00390	0.00339
	(0.0930)	(0.0950)	(0.0927)	(0.0999)	(0.0888)	(0.0916)	(0.0896)	(0.0955)
Toilet	−0.690***	−0.505***	−0.357**	−0.223	−0.640***	−0.386**	−0.478***	−0.309*
	(0.183)	(0.165)	(0.180)	(0.165)	(0.175)	(0.159)	(0.173)	(0.158)
Water	−0.0677	−0.178	−0.285	−0.365**	−0.170	−0.307*	−0.210	−0.324*
	(0.189)	(0.178)	(0.194)	(0.179)	(0.181)	(0.172)	(0.187)	(0.171)
Central	−0.948	−0.858*	−1.679***	−1.172**	−1.159**	−0.979**	−1.977***	−1.381***
	(0.590)	(0.479)	(0.547)	(0.463)	(0.564)	(0.462)	(0.528)	(0.443)
Northern	0.0778	0.165	−1.300**	−0.703	−0.187	−0.0259	−1.615***	−0.953**
	(0.605)	(0.491)	(0.570)	(0.482)	(0.578)	(0.473)	(0.551)	(0.462)
Eastern	−0.502	−0.269	−2.051***	−1.091**	−0.776	−0.484	−2.399***	−1.272**
	(0.609)	(0.503)	(0.580)	(0.553)	(0.582)	(0.485)	(0.560)	(0.529)
Kordufan	0.816	1.023**	−0.304	0.413	0.447	0.774	−0.709	0.137
	(0.611)	(0.507)	(0.572)	(0.515)	(0.584)	(0.489)	(0.553)	(0.493)
Darfur	−0.841***	1.134**	0.678	0.391	−1.207**	0.553	−0.0782	−0.151
	(0.067)	(0.501)	(0.566)	(0.475)	(0.584)	(0.483)	(0.546)	(0.455)
First-stage partial R^2	0.111	0.093	0.106	0.088	0.114	0.096	0.113	0.089
Cragg–Donald test	456.4(0.00)	103.3(0.00)	396.5 (0.00)	58.9 (0.000)	456.4 (0.00)	103.3(0.00)	396.5(0.00)	58.9 (0.000)
Observations	5,438	5,438	5,315	5,315	5,438	5,438	5,315	5,315

Note(s): Standard errors in parentheses; *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Standard errors clustered at the village/cluster level

The key independent variable (i.e. land) is a continuous variable, measured in the number of hectares

"Land (cluster average)" denotes that the land variable is instrumented by the cluster average of land size, while "Land (cluster ratio)" is instrumented by the ratio of land owners to non-owners

Source(s): Author's own work

landholding varies between boys and girls, as girls tend to benefit more from agricultural land ownership compared to boys.

5. Conclusion and policy implications

Motivated by the high prevalence of child malnutrition in rural Sudan, this study investigates the impact of agricultural landholding on child nutritional status, emphasizing on the gendered effect. The analysis utilized data from the 2014 MICS, covering a sample of 10,753 children in rural Sudan. To address the potential issues of sample selection bias and endogeneity, the study employed the IV method.

The results from different estimation methods and model specifications indicate that landholding exerts a negative and significant impact on child malnutrition in the full and female samples. However, for the male sample, the results reveal that agricultural land ownership does not play a significant role in improving the nutritional outcomes of male children. This finding highlights a gender disparity in the effect of landholding on the nutrition status of children in rural Sudan, with girls benefiting significantly more from agricultural land ownership compared to their male counterparts. These results remain robust across various model specifications and estimation techniques.

Based on the findings presented above, it is evident that policy actions aimed at promoting agricultural development can play a crucial role in enhancing the nutritional situation of children under five in rural Sudan. Therefore, improving food and nutrition security should prioritize land reform as a central agenda in Sudan. Moreover, addressing the prevalent issue of unequal land distribution is crucial, given the widespread landholding inequality in rural areas. We recommend the implementation of appropriate regulations and legislation to combat land grabbing and simultaneously encourage land ownership by farmers. In addition, addressing gender disparities in landholding and supporting women's land ownership should be emphasized. This would have a positive influence on improving the child nutrition status in rural Sudan. Furthermore, given the potential challenges associated with adjusting land policies in the short term, it is imperative that policymakers pay special attention to improving the nutrition of girls in families without land.

While acknowledging the importance of this study, it is essential to underscore several limitations. First, there exist numerous pathways through which landholding can influence the child's nutritional status, which we were unable to examine due to the lack of relevant data in the survey. For instance, land ownership may increase household income and availability of food, hence improving children's nutrition within the household. Second, the data utilized in this study were obtained from the 2014 MICS, which primarily focuses on health and nutritional indicators, with limited information on economic characteristics and land-related issues. Third, this survey utilized the sole existing MICS survey in Sudan during the last three decades; hence, the absence of frequent MICS surveys hindered our ability to examine the influence of landholding on child malnutrition over time.

Finally, the study's findings offer valuable insights that can potentially inform and guide agricultural policies, not only in developing countries facing challenges related to child nutrition but also in countries where agriculture plays a key role in food security, such as China. We argue that there are some consistencies between Sudan and China concerning land ownership and child nutrition status. Primarily, both countries exhibit gender inequality in land ownership among rural households, with women having limited access compared to men. In addition, Sudan and China face gender disparities in children's nutrition status, evidenced by higher rates of stunting and underweight among rural male children compared to females in both countries. Building on these similarities, policymakers in Sudan and China should address gender disparities in land ownership by promoting women's access to land. This can enhance women's economic empowerment and strengthen their contribution to improving food security and child nutrition status.

Notes

1. The study exclusively examines the nutritional status of children under five because this group is the most vulnerable to malnutrition in developing countries (Bhutta *et al.*, 2017; Kanan and Swar, 2016; Chawla *et al.*, 2020). In addition, malnutrition during this period can have long-term impacts on physical and cognitive development (Mwene-Batu *et al.*, 2020; Galler *et al.*, 2021).
2. In practice there are three main anthropometric indicators: HAZ, WAZ and weight-for-height. However, the current study excludes WHZ because its performance is reasonable, while most of the child nutritional problems in Sudan are concentrated on stunting (HAZ) and underweight (WAZ) (see Appendix B).
3. We are aware of the fact that the term land use is a broader concept that implies access to land and use of land through both landholding and land hiring. Given the lack of reliable information regarding land hiring in Sudan, for the purpose of our analysis in this paper, we use the term land use to refer to measure landholding in Sudan.
4. Results of first-stage regressions for both male and female samples are available upon request.
5. To facilitate the results' interpretation, we reversed and rescaled the standard deviation of Z-scores into positive values between zero and 4. This makes our interpretation aligns with the direction of basic analysis, as an increase in score indicates malnutrition.

References

Abdalla, M.A., Sulieman, S.A., El Tinay, A.H. and Khattab, A.G.H. (2009), "Socio-economic aspects influencing food consumption patterns among children under age of five in rural area of Sudan", *Pakistan Journal of Nutrition*, Vol. 8 No. 5, pp. 653-659, doi: 10.3923/pjn.2009.653.659.

Allendorf, K. (2007), "Do women's land rights promote empowerment and child health in Nepal?", *World Development*, Vol. 35 No. 11, pp. 1975-1988, doi: 10.1016/j.worlddev.2006.12.005.

Alredaisy, S.M.A., Ibrahim, H.S. and Saeed, H.O.E.H. (2012), "Rural-urban profile of nutritional status of Sudanese children less than ten year old: rural Western Kordofan and urban Khartoum state", *Academic Research International*, Vol. 3 No. 2, p. 589.

Angrist, J.D. and Pischke, J.S. (2009), *Mostly Harmless Econometrics: An Empiricist's Companion*, Princeton University Press.

Asfaw, M., Wondaferash, M., Taha, M. and Dube, L. (2015), "Prevalence of undernutrition and associated factors among children aged between six to fifty nine months in Bule Hora district, South Ethiopia", *BioMed Central (BMC) Public Health*, Vol. 15 No. 1, pp. 1-9, doi: 10.1186/s12889-015-1370-9.

Babiker, M. (2013), "Mobile pastoralism and land grabbing in Sudan: impacts and responses", in *Pastoralism and Development in Africa*, Routledge, pp. 177-185.

Bhutta, Z.A., Berkley, J.A., Bandsma, R.H., Kerac, M., Trehan, I. and Briend, A. (2017), "Severe childhood malnutrition", *Nature Reviews Disease Primers*, Vol. 3 No. 1, pp. 1-18, doi: 10.1038/nrdp.2017.67.

Bukusuba, J., Kaaya, A.N. and Atukwase, A. (2017), "Predictors of stunting in children aged 6 to 59 months: a case–control study in Southwest Uganda", *Food and Nutrition Bulletin*, Vol. 38 No. 4, pp. 542-553, doi: 10.1177/0379572117731666.

Chawla, S., Gupta, V., Singh, A., Grover, K., Panika, R.K., Kaushal, P. and Kumar, A. (2020), "Undernutrition and associated factors among children 1-5 years of age in rural area of Haryana, India: a community based cross-sectional study", *Journal of Family Medicine and Primary Care*, Vol. 9 No. 8, pp. 4240-4246, doi: 10.4103/jfmpc.jfmpc_766_20.

Cragg, J.G. and Donald, S.G. (1993), "Testing identifiability and specification in instrumental variable models", *Econometric Theory*, Vol. 9 No. 2, pp. 222-240, doi: 10.1017/s0266466600007519.

Eastwood, R., Lipton, M. and Newell, A. (2010), "Farm size", in *Handbook of Agricultural Economics*, Vol. 4, pp. 3323-3397.

Ebaidalla, E.M. (2021), "Does health insurance reduce catastrophic health expenditure in Sudan?", *The Journal of Developing Areas*, Vol. 55 No. 4, pp. 11-25.

Ebaidalla, E.M. (2022), "Understanding participation in non-farm activities in rural Sudan: across-sector study of irrigated and rainfed agricultural systems", *International Journal of Social Economics*, Vol. 49 No. 11, pp. 1589-1606, doi: 10.1108/ijse-02-2022-0092.

Ebaidalla, E.M. (2023), "Inequality of opportunity in child health in Sudan: across-region study", *Journal of Economic Development*, Vol. 48 No. 1, pp. 59-83.

Elhadary, Y.A.E. (2010), "Challenges facing land tenure system in relation to pastoral livelihood security in Gedarif State, Eastern Sudan", *Journal of Geography and Regional Planning*, Vol. 3 No. 9, pp. 208-218.

Elhadary, Y. and Abdelatti, H. (2016), "The implication of land grabbing on pastoral economy in Sudan", *World Environment*, Vol. 6 No. 2, pp. 25-33.

Galler, J.R., Bringas-Vega, M.L., Tang, Q., Rabinowitz, A.G., Musa, K.I., Chai, W.J., Omar, H., Abdul Rahman, M.R., Abd Hamid, A.I., Abdullah, J.M. and Valdes-Sosa, P.A. (2021), "Neurodevelopmental effects of childhood malnutrition: a neuroimaging perspective", *NeuroImage*, Vol. 231, 117828, doi: 10.1016/j.neuroimage.2021.117828.

Gillespie, S., Harris, J. and Kadiyala, S. (2019), "The agriculture-nutrition disconnect in India: what do we know?", *Gates Open Research*, Vol. 3, p. 1115.

International Food Policy Research Institute, (IFPRI) (2011), "Leveraging agriculture for improving nutrition and health: highlights from an international conference", Washington, DC, (IFPRI).

Kabubo-Mariara, J., Ndenge, G.K. and Mwabu, D.K. (2009), "Determinants of children's nutritional status in Kenya: evidence from demographic and health surveys", *Journal of African Economies*, Vol. 18 No. 3, pp. 363-387, doi: 10.1093/jae/ejn024.

Kadiyala, S., Joshi, P.K., Dev, S.M., Kumar, T.N. and Vyas, V. (2011), "Strengthening the role of agriculture for a nutrition secure India", Policy note, India International Food Policy Research Institute (IFPRI), New Delhi.

Kanan, S.O. and Swar, M.O. (2016), "Prevalence and outcome of severe malnutrition in children less than five-year-old in Omdurman Paediatric Hospital, Sudan", *Sudanese Journal of Paediatrics*, Vol. 16 No. 1, pp. 23-30.

Khalid, F.A., Ali, A.K., Ali, S.A., Mosmar, Z.Y., Salih, S.S., Salman, T.K., Desogi, M.A., Soghaier, M.A., Mohammed, E.E. and Mohammed, A.A. (2017), "Households' dietary habits and food consumption patterns in Hamishkoreib locality, Kassala State, Sudan", *Journal of Ethnic Foods*, Vol. 4 No. 3, pp. 181-186, doi: 10.1016/j.jef.2017.08.009.

Manda, J., Gardebroek, C., Khonje, M.G., Alene, A.D., Mutenje, M. and Kassie, M. (2016), "Determinants of child nutritional status in the eastern province of Zambia: the role of improved maize varieties", *Food Security*, Vol. 8 No. 1, pp. 239-253, doi: 10.1007/s12571-015-0541-y.

Menon, N., Van der Meulen Rodgers, Y. and Nguyen, H. (2014), "Women's land rights and children's human capital in Vietnam", *World Development*, Vol. 54, pp. 18-31, doi: 10.1016/j.worlddev.2013.07.005.

Musa, T.H., Musa, H.H., Ali, E.A. and Musa, N.E. (2014), "Prevalence of malnutrition among children under five years old in Khartoum State, Sudan", *Polish Annals of Medicine*, Vol. 21 No. 1, pp. 1-7, doi: 10.1016/j.poamed.2014.01.001.

Mwene-Batu, P., Bisimwa, G., Baguma, M., Chabwine, J., Bapolisi, A., Chimanuka, C., Molima, C., Dramaix, M., Kashama, N., Macq, J. and Donnen, P. (2020), "Long-term effects of severe acute malnutrition during childhood on adult cognitive, academic and behavioural development in African fragile countries: the Lwiro cohort study in Democratic Republic of the Congo", *PLoS One*, Vol. 15 No. 12, e0244486, doi: 10.1371/journal.pone.0244486.

Rammohan, A. and Pritchard, B. (2014), "The role of landholding as a determinant of food and nutrition insecurity in rural Myanmar", *World Development*, Vol. 64, pp. 597-608, doi: 10.1016/j.worlddev.2014.06.029.

Rashad, A.S. and Sharaf, M.F. (2019), "Does maternal employment affect child nutrition status? New evidence from Egypt", *Oxford Development Studies*, Vol. 47 No. 1, pp. 48-62, doi: 10.1080/13600818.2018.1497589.

Samuel, A., Osendarp, S.J., Feskens, E.J., Lelisa, A., Adish, A., Kebede, A. and Brouwer, I.D. (2022), "Gender differences in nutritional status and determinants among infants (6-11 m): a cross-sectional study in two regions in Ethiopia", *BMC Public Health*, Vol. 22 No. 1, p. 401, doi: 10.1186/s12889-022-12772-2.

Siddiqui, M., Goli, S. and Reja, T. (2017), "Linkages between households' agricultural landholding and child nutritional status in rural India", Asia Research Institute (ARI) Working Paper No. 257, Asia Research Institute, Singapore, National University of Singapore.

Slavchevska, V. (2015), "Agricultural production and the nutritional status of family members in Tanzania", *Journal of Development Studies*, Vol. 51 No. 8, pp. 1016-1033, doi: 10.1080/00220388.2015.1018906.

The Sudan Multiple Indicator Cluster Survey (MICS) (2014), "MICS' full report for Sudan", available at: https://www.unicef.org/sudan/media/1146/file/Multiple-Indicator-Cluster-Survey-Report-2014%20.pdf (accessed 12 February 2018).

The United Nations Children's Fund (UNICEF) (2014), "Sudan Multiple indicator cluster survey", available at: http://mics.unicef.org/surveys (accessed 10 June 2018).

The World Bank (2007), *From Agriculture to Nutrition: Pathways Synergies and Outcome*, the World Bank, Washington, DC.

The World Health Organization (WHO) (2006), "WHO child growth standards: length/height-for- age, weight-for-age, weight-for-length, weight-for-height, and body mass index-for- age", in *Methods and Development*, World Health Organization, Geneva.

Tiwari, S., Skoufias, E. and Sherpa, M. (2013), "Shorter, cheaper, quicker, better: linking measures of household food security to nutritional outcomes in Bangladesh, Nepal, Pakistan, Uganda, and Tanzania", World Bank. Policy Research Working Paper 6584, The World Bank, Washington, DC.

Supplementary material

The supplementary material for this article can be found online.

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