The effect of smallholder land tenure on child malnutrition in Nigeria

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ABSTRACT

Most farmers in Nigeria are food-insecure smallholders without secure land tenure. Children growing up in these households may be at higher risk of malnutrition. However, there is a paucity of evidence of the effect of land tenure on child nutrition. The present paper examines whether smallholders' mode of land acquisition and tenure documentation could influence child malnutrition in Nigeria. The paper relied on the three-round Nigerian nationally representative panel data of smallholder farming households with small children. The World Health Organisation's standards were used to determine child anthropometric deficits such as stunting, wasting, underweight, overweight and stunted-overweight. The study analysed the effect of smallholders' mode of land acquisition and tenure documentation on child malnutrition using the flexible panel difference-in-difference (*flexpaneldid*) model and fixed effect (FE) logistic regression. Households on family-inherited land were more likely to have stunted, underweight

and overweight children. However, households that held community-distributed land were less likely to have stunted, overweight and underweight children. While the formal land certificate holders had a 13 percent chance of having stunted children, the informal land document holders were seven percent and five percent less likely to have wasted and underweight children. Smallholder land tenure had a small but relevant effect on reducing child malnutrition with community-level land distribution and informal land documents in Nigeria.

*Keywords:*child malnutrition, land tenure, smallholders, Nigeria, *flexpaneldid* model

1. Introduction

Malnutrition is a global phenomenon which overburdens the public health system and constrains socioeconomic development (UNICEF, WHO & WBG 2021). Many developing countries continue to suffer from chronic food insecurity and high levels of malnutrition (SOFI 2021). Malnutrition arises from the cumulative effects of inadequate energy and nutrient intake and infections preventing food assimilation (Bourke et al., 2016). In 2020, approximately 2.2 million children under five years of age suffered from wasting and twelve million children under five years of age suffered from stunting in Nigeria (SOFI 2021). The country had the second and third-highest number of stunted and wasted children globally, with respective national prevalence rates of 35.3 percent and 6.5 percent of children under five years of age (SOFI 2021).

Children of food-insecure households are at higher risk of severe malnutrition (Agbadi et al., 2017). Severe malnutrition exposes children to the risk of infections, morbidity and mortality

(Khan et al., 2019). In addition, malnutrition leads to poor cognitive development, educational performance and ultimately low adulthood productivity (Grantham-McGregor et al., 2007).

One way to address malnutrition among farmers is by integrating nutrition into agricultural programmes (Kadiyala et al., 2021). Increased agricultural growth correlates with decreased hunger, stunting and child mortality in sub-Sahara African countries (Pingali & Abraham 2020). Nutrition-sensitive agriculture is a pathway to improve nutrition, increase the availability, access, and utilisation of nutritious foods, and create opportunities for generating income from the sale of surplus (Hendrik et al. 2020; Ruel et al. 2018). Nutrition-sensitive farming practices can increase diverse diets and nutritious food intake through aquaculture, agricultural extension services, biofortification, homestead food production, irrigation intervention, livestock and dairy programmes and nutrition-sensitive value chains (Ruel et al., 2018; Hawkes et al., 2020). Nigeria's government is committed to addressing household malnutrition by implementing the Agricultural Sector for Food Security and Nutrition Strategy (AFSNS 2016-2025) to promote nutrition-sensitive agricultural intervention (FMARD, 2017). The AFSNS makes no mention of the role of land tenure in improving food security and nutrition. However, the Agriculture Promotion Policy (2016 – 2020) recognises that the entitlement and documentation of land ownership is necessary to assist using land as collateral to access loans, incentivise small farmers to invest in land improvements and raise their productivity, address gender biases and create a transparent and liquid market for agricultural land (FMARD, 2016).

While farmers are less motivated to make plausible investments or participate in income-generating land contracts, the lack of entitlement and land ownership constraints agricultural

development and can contribute to poor child health (Simbizi et al., 2014; Harris-Fry et al., 2020). Amidst global demographic growth, rapid urbanisation, environmental degradation and climate change, increased competition to acquire land raises the demand for land in Nigeria (Ghebru et al., 2014). However, about 88 percent of farmers in Nigeria produced food on less than two hectares of land and were constrained with poor land tenure (CGAP 2017; FAO 2018). Addressing poor land governance requires understanding the impact of existing land tenure systems on critical productivity and welfare indicators (Deininger & Ali 2008). Children in farming households where land rights are insecure may face a higher prevalence of malnutrition (Kosec & Shemyakina 2018). However, there is currently no available evidence of the effect of land tenure on child nutrition in Nigeria. The present paper sought to address this gap.

The remainder of the paper is organised as follows. Section 2 discusses the background of the land tenure systems in Nigeria. Section 3 reviews literature on the connections between land tenure and nutritional status. Section 4 focuses on material and methods, including descriptions of the data and data analysis. Section 5 presents the results and discussion. Finally, section 6 concludes and suggests recommendations for public policy.

2. Background of land tenure systems in Nigeria

Land tenure systems in Nigeria range from statutory to customary tenure systems. The statutory or legal system embraces the de jure (formal). In contrast, the customary land tenure system focuses on the *de facto* (informal) situation to define land acquisition (how land is held) and land rights (what holders may do with the land) (Hall et al., 2019). The 1978 Nigerian Land Use Act

(LUA) defined the formal system and full vested ownership of land to the State and Local governments, abolished customary land freehold rights, and granted leasehold rights to land users for 99 years (Ghebru et al., 2014). The State Governor and local government councils give legal recognition of land use rights by issuing statutory certificates of occupancy to urban land users and customary certificates of occupancy to rural land users. By law, farmers are either statutory or official customary occupiers of land. The term "customary certificate of occupancy" in the 1978 LUA was formalised and does not mean that the certificate is connected to the customary land tenure system, which defines land acquired and land rights using communal accepted rules (Hall et al., 2019).

Despite the significance of formal land titles to secure land use rights, rent-seeking and corruption under 1978 LUA and the high cost of processing land registration limit the acquisition of legal land titles and initiate the use of informal land right documents. The registration of land rights at the state or local land registry involves submitting informal land documents such as a deed of transfer or perimeter survey plan (Kehinde et al., 2021), limiting the suitability of formal land registration for land users with no document.

The land purchases occur under the 99-year lease afforded by the 1978 LUA rather than freehold titles in Nigeria. Unless such transactions are registered with the state, there is no formal entitlement or recognition of rights. Without the formal land right documentation, such land cannot be used as collateral. The 2009 land reform programme sought to address the shortcomings of the 1978 LUA (Hall et al., 2019). However, the land reform programme failed because of the lack of

political will to reform 1978 LUA and the disagreements between customary and formal tenure institutions (Hall et al., 2019). No change to the 1978 LUA has yet been affected.

While the study focused on the context of Nigerian smallholder farm households, the findings may be relevant for other developing countries, where smallholder agriculture relies on similar land tenure systems. For example, 13 African states (in Table 1) have land policies and laws that recognise customary land tenure but are widely untitled (Burundi, Cameroon, Comoros, Ivory Coast, Madagascar, Namibia, Niger, Sierra Leone, Zambia) (Wily 2018; USAID 2016). Others abolished customary freehold land tenure and land is held or perceivably owned under customary tenure institutions (Nigeria, Senegal, Tanzania, Zimbabwe) (Wily 2018; USAID 2016). As a result, unregistered land has become prevalent in Africa and susceptible to conflict and expropriation by governments (USAID 2016).

Theory predicts that the mode of land acquisition and formal land right documentation can give people a sense of access to and control over land rights (Ghebru et al., 2014). This paper investigated whether the mode of land acquisition and land rights documentation under formal and informal tenure systems in Nigeria influenced child nutrition between 2012 to 2018. The findings could inform the need for urgent policy reform in Nigeria and other African countries with state ownership of land to address child malnutrition.

Table 1: African countries with untitled land of customary tenure alongside the statutory land laws

Country	Statutory	Customary	Dominant tenure system	Reason for untitled land
Burundi	The untitled land owned by the state through the 2011 Land Code	Only titled customary lands recognised by law	Untitled customary land (less than 5% of all land is registered)	The costly and complex registration process
Cameroon	The untitled land owned by the state through the 1974 Land Law	Only registered customary ownership recognised by law	Untitled customary lands (less than 3% of rural land is registered)	The costly and complex administration process
Comoros	The illegal occupation of land belonging to the state under the 2015 Land Law	The registered customary land ownership recognised by law	Unregistered customary lands (low proportion of all land is registered	Costly registration process
Ivory Coast	All unregistered land is the property of the state under the 1998 Rural Land Law	The registered customary rights to land are recognised by law	Unregistered customary rights to lands (less than 2% of rural land registered)	Costly registration process
Madagascar	The 2005 National Land Law recognised both titled untitled land	The government passed a law to assert that untitled land be titled to recognise rights	Unregistered customary land (Only around 7% land is titled)	Land registration is demanded and based on contestable procedures. The local land office is under-funded with poor technical training support
Namibia	Unregistered ownership rights to land are unknown by the 1998 National Land Reform Act	Registered customary lands were recognised under law	Unregistered customary land	Slow registration of right. The process of formal titling is time-intensive

Country	Statutory	Customary	Dominant tenure system	Reason for untitled land
Niger	The 1993 Rural land code declared all unregistered land as property of the state	Recognised by the law and land can be registered	Unregistered customary land	Under-functioning of commission to register land
Nigeria	Both titled and untitled land owned by state through the 1978 Land Use Act	Existing despite being abolished by 1978 LUA	Unregistered customary land (less than 3% land registered)	High cost and procedures of obtaining formal certificates, lack of administrative support for service delivery
Tanzania	Both titled and untitled land belongs to the state under the 1999 Land Act and Village Land Act	Formal law recognise customary land rights but formally grants (statutory) usufruct land rights	Customary (unwritten) tenure arrangements dominate	The process of issuing Certificates of Village Land (CVL) as Certificates of Customary Right of Occupancy has been slow
Senegal	97% titled and untitled land owned by the government according to the 1964 National Domain Law. Only 2-3% of registered privately freehold land	Despite efforts of formal law to control land tenure, customary land tenure institution continues to land rights	Unregistered customary landholdings. Few registered landholdings (ownership of rights to land) in rural and urban areas	High cost of titling and long registration process of occupancy rights.
Sierra Leone	Sierra Leone's 2005 National Land Policy protect the common national or communal property held in trust for the people	Unwritten customary land though some have purchase and sales agreements/title deeds and tax clearance certificates as proof.	Chieftaincy or community land tenure	No registration or legal framework, application of uncodified customary law, no reliable record of landholdings, the prevalence of fraudulent land documents,

Country	Statutory	Customary	Dominant tenure system	Reason for untitled land
				ignoring/changing terms of lease
Zambia	Non-customary land deems to be State land under the 1995 Land Act	Recognised customary (often unwritten) under law	6% customary landholders have some forms of customary landholder certificates (outside Statutory)	High cost, low level of awareness
Zimbabwe	Both titled and untitled lands are in the state through the Zimbabwe National Union-Patriotic Front Law	The customary/informal land tenure is active despite the nationalisation of land in some rural	Informal settlements exist	The country has no legislative framework for the regularisation of informal settlements

136 Source: USAID 2016; Habitat III 2016

3. Understanding the connections between land tenure and nutritional status

Land rights serve as fundamental human rights to increase economic efficiency, productivity, empowerment and welfare (Allendorf 2007). There are four ways in which land tenure can indirectly affect a child's nutritional status. Firstly, land ownership can empower vulnerable households to undertake efficient production decisions, which increase food and incomes, raising access to healthy diets, including water and sanitation (Landesa 2012; Rodgers & Kassens 2018). Secondly, land registration in women's names within Vietnam enhanced women's land rights (Menon et al., 2014). Households with registered land titles have the potential to access formal financial services (Landesa 2012) through collateral, which can ease liquidity constraints (Rodgers & Kassens 2018).

Thirdly, land rights can boost resilience to cope with shocks such as financial crisis, land-related conflicts, unfair expropriation by the government and social discrimination (Allendorf 2007). Households can also cope with food price shocks when land ownership encourages home gardening, providing space for keeping poultry and livestock and producing fruits and vegetables for family consumption (Landesa 2012). Fourthly, farmers with secure tenure have an incentive to invest in farm technology (i.e. irrigation, improved seed varieties, biofortified seeds, improved pest management) (Holden 2020). Thus, secure tenure can guarantee farmers reap high profits from farm surplus and potentially improve child and household nutrition and health outcomes (Allendorf 2007).

There is limited evidence published on the relationship between smallholder land tenure and child malnutrition as measured using anthropometric indicators. Literature on the impact of land tenure has shown mixed findings on nutritional outcomes of households and individuals across the globe. In Nepal, Allendorf (2007) found that female landowners (i.e., mothers) were less likely to have severe underweight children. Households with limited or no land were more likely to be food insecure and have stunted and underweight children in India (Siddiqui et al., 2017). In the Democratic Republic of Congo DRC, Kasiwa and Muzabedi (2020) reported that landowners with large farmland sizes had children with normal Body Mass Index (BMI) and mothers with a low risk of anaemia. A study conducted by Rodger and Kassen (2018) in Papua New Guinea confirmed that mothers with livelihood assets, including land have fewer stunted and wasted children.

Ghebru and Holden (2013) reported that female land titleholders had well-breastfed and normal-weight children in Ethiopia. In the Kyrgyz Republic, Kosec and Shemyakina (2018) revealed that households that benefitted from long-term land titling programmes had low numbers of wasted children in the age brackets of 0 – 24 months and 25 – 60 months. On the contrary, formal land titleholders in urban areas had a higher possibility of having stunted and/or overweight children in Peru (Vogl 2007). A study in Argentina found urban land titling to have a positive influence on weight-for-height but not on height-for-age in children (Galiani & Schargrodsky 2004). Merten and Haller (2008) used cross-section data in Zambia to discover how the loss of resources such as pasture, fishery and woodland reduced the height-for-age and weight-for-height z-scores of children that could lead to the development of acute and chronic malnutrition. However, to the best of the authors' knowledge, no studies have been conducted in Nigeria linked the smallholder land tenure to child malnutrition.

Weak land rights affect smallholder agriculture in Nigeria. The Nigerian 1978 Land Use Act (LUA) has not strengthened the land rights of the smallholders, affecting the productivity and food security and nutrition of their households. As a result, the undernourished people in Nigeria had increased from 7.1 percent in 2004-06 to 14.6 percent in 2008-20 (SOFI 2021). The proportions of stunted and wasted children in the country had risen above the Africa average of acute and chronic malnutrition (see Figure 1). Child overweight prevalence increased from 2.1 percent in 2018 to 5.7 percent in 2021 (Figure 1). Many malnutrition cases were associated with unequal land distribution and food insecurity (Bishwajit 2015; SOFI 2019). The Voluntary Guidelines for Responsible Governance of Land Tenure in the Context of Food Security (VGGTs) (FAO 2012) and the Framework and Guideline on Land Policy in Africa (AU, AfDB & UN ECA 2010) were established to promote access, use and management of land. The guidelines can support the Nigerian Agricultural Sector for Food Security and Nutrition Strategy (AFSNS 2016-2025) to promote nutrition-sensitive agriculture in response to SDG 2, addressing hunger and malnutrition by 2030 (FMARD 2017). However, evidence is needed to guide the objective's implementation.

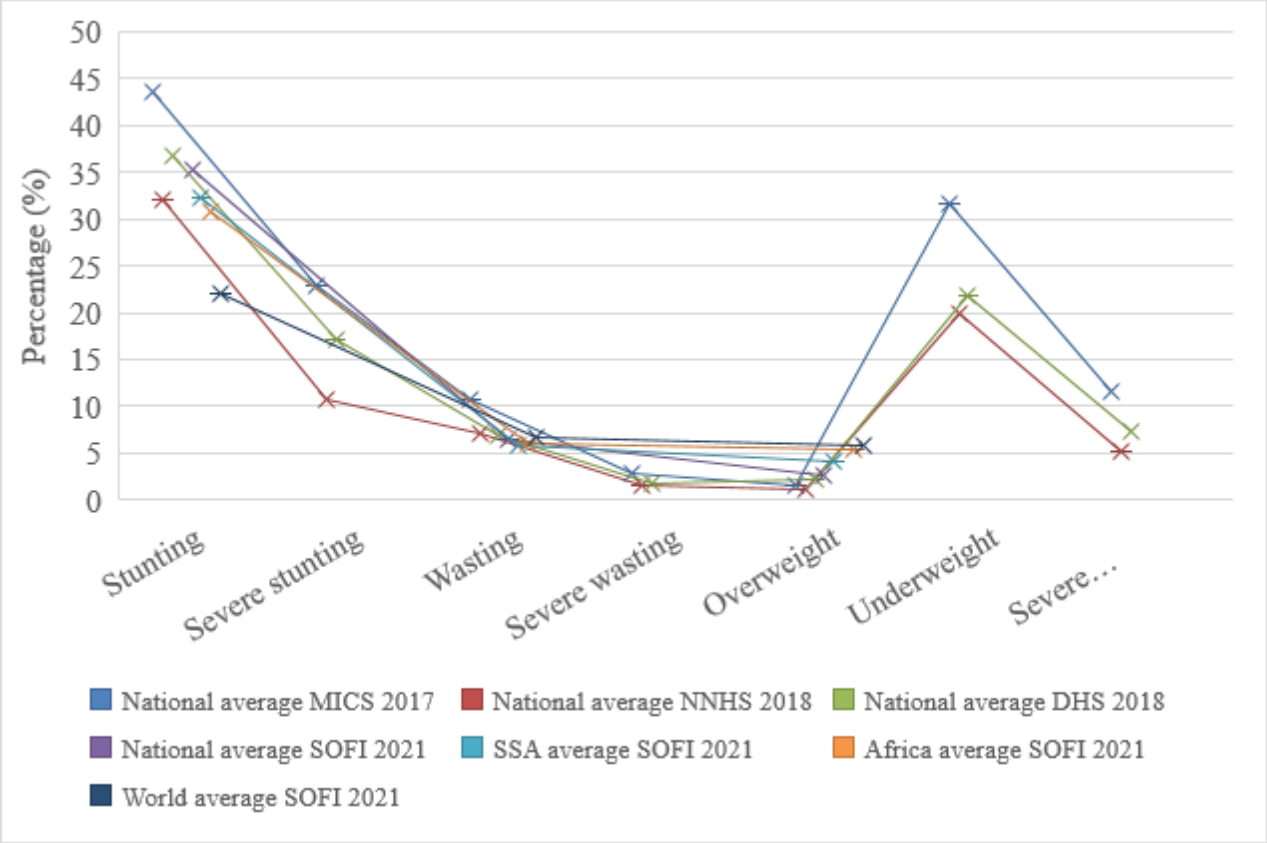


Figure 1*:* Percentage of children of under 5years old classified as malnourished in Nigeria Source: 5th Multiple Indicator Cluster Survey MICS (NBS & UNICEF 2017), National Nutrition and Health Survey NNHS (NBS, NPC & NFMH 2018) and 6th Nigeria Demographic and Health Survey NDHS (NPC & ICF 2019). The State of Food Insecurity SOFI (SOFI 2021).

Kasiwa and Muzabedi (2020) reported that 70% of households with poor diets owned agricultural land in 2014 Demographic and Health Survey of the Democratic Republic of Congo (DRC). The study argued that access to land may be necessary but what matters is how to access and control agricultural land to better explain the relationship between land tenure and individual household nutrition (Kasiwa & Muzabedi 2020). The practice of land tenure may affect certain land rights and equal land ownership. Since agricultural practices at the farm level require sound land tenure to improve household food security and nutrition (Landesa 2012), the present study examines whether smallholder land tenure could affect child anthropometric deficits in Nigeria's context.

4. Material and Methods

This study used Nigeria's national representative panel data of the living standards measurement study-integrated surveys on agriculture (LSMS-ISA) for data analysis. The data were accessed from the World Bank database following the completion and submission of a mini questionnaire. The first round of data collection started in 2010-11 with a sample of 5 000 households across the 36 states in Nigeria and the Federal Capital Territory (FCT). Rounds two, three and four of the survey were conducted in 2012-13, 2015-16 and 2018-19, respectively (NBS & The World Bank 2021). Each survey round was conducted during the post-planting period and repeated in the post-harvest period. The samples included agricultural households where children under five years of age resided. One thousand, eight hundred and fifteen sub-sampled smallholders were drawn from the total population in 2012-13, 2015-16 and 2018-19 general household survey. The panel database provided information on household head characteristics, smallholder land tenure inventories, birth dates, weight, and height of 1,669 children aged 0 – 59 months.

4.1 Description of the variables

A binary variable was created for each of the five modes of land acquisition: community distribution, land obtained free of charge, inherited land, purchased land (state registered or unregistered) and rentals. In addition, a second analysis was conducted using a binary variable for formal and informal tenure security regardless of the acquisition mode. The first category included formal documentation of rights and entitlements by holding formal land certificates, including statutory certificates of occupancy, customary certificates or rights of occupancy. The second

category included informal documentation of rights and entitlements by having informal land documents such as approved and unapproved survey plans, registered and unregistered purchase agreements, building plans, government allocation receipts and family receipts not recognised by Nigeria's 1978 Land Use Act as formal land titles (NBS & World Bank, 2021). Table 2 presents the summary of variables for data analysis.

Table 2: Summary of the variables used for analysis

Class of variable	Data requirement	Unit of measurement	Expected sign
Dependent variables at the individual (i.e., children) level			
Child nutritional outcome of under 60 months in a household	Height	Centimetres	Derivation of indicators in Table 2
	Weight	Kg	
	Age	Month	
	Sex	female=1, male=0	
Explanatory variables at the household levels			
Mode of land acquisition indicators	Family-inheritance	1=inherited, 0=otherwise	–
	Outright purchase (state registered and unregistered)	1=purchased, 0=otherwise	–
	Community distribution	1=allocated, 0=otherwise	–
	Used land free of charge	1=used, 0=otherwise	–
	Rented land	1=rented, 0=otherwise	+
Documentation of land rights and entitlements indicators	Formal land certificate	1=hold, 0=otherwise	–
	Informal land documents	1=hold, 0=otherwise	–
Control variables at the household level			
Household-head characteristics	Age	Years	For matching analysis
	Sex	1=female, 0=male	
	Literate	Binary	
	Educational attainment	1=none, 2=FSLC, 3=MSLC, 4=Voc/comm., 5=JSS, 6=SSS (O level), 7=A level, 8=NCE/OND/Nursing, 7=BA/BSC/HND, 8=Technical/Prof, 9=Master and Doctorate.	
	Household size	Number	

Class of variable	Data requirement	Unit of measurement	Expected sign
	Number of plots	Number	
	Household-head's relationship with a child	1=adopted child, 2=stepchild, 3=own child, 4=grandchild, 5=brother/sister, 6=niece/nephew, 7=brother/sister-in-law, 8=other relation and 9=other non-relation.	
	Cooperative membership	1=yes, 0=no	
	Zone	1=North-Central, 2=North-East, 3=North-West, 4=South-East, 5=South-South and 6=South-West	
	Sector	Rural=1, 0=Urban	

Table 3 presents a range of anthropometric measures of children under five years of age. These measurements were derived from the standard deviation scores (z-scores) using the mean of the reference population to calculate the anthropometric indicators (WHO 1995; 2006). Children whose height-for-age was less than two standard deviations (-2SD) below the median of the recommended reference population were classified as stunted (short for their age). Children whose weight-for-height was below minus two standard deviations (-2SD) from the median of the recommended reference population would be wasted (WHO 1995; 2006). The BMI was derived from children's weight divided by their height in centimetres square (Table 3). Children whose BMI-for-age was above plus two standard deviations (+2SD) from the median of the recommended reference population were considered overweight (WHO 2006). The WHO Anthro STATA command helped categorise BMI into normal, overweight and obesity (World Bank 2008). While the WHO growth standards include a BMI chart beginning at birth, the authors acknowledge that the use of the BMI-for-age growth chart is not recommended for children younger than age two years. The BMI in infancy is based on recumbent length rather than stature and, there has been

little research on what BMI calculated from length means in infancy and on the consequences of high or low BMI in infancy.

Table 3: Descriptive classification of child anthropometry, cut-off range and prevalence's reference

Indicator †	Anthropometric variable	Cut-off value‡	Prevalence's reference (%)
Stunting	Height-for-age (HAZ)	<-2 z-scores	Very low (2.5-<10), Low (2.5-<10), Medium (10-<20), High (20-<30), Very high (≥30) (UNICEF, WHO, WBG. 2021).
Wasting	Weight-for-height (WHZ)	<-2 z-scores	Very low (<2.5), Low (2.5-<5), Medium (5-<10), High (10-<15), Very high (≥15) (UNICEF, WHO, WBG. 2021).
Overweight	BMI -for-age (BAZ)	>2 z-scores	Very low (<2.5), Low (2.5-<5), Medium (5-<10), High (10-<15), Very high (≥15) (UNICEF, WHO, WBG. 2021).
Underweight	Weight-for-age (WAZ)	<-2 z-scores	Low (<10), Medium (10-19), High (20-29), Very high (≥30) WHO (1995).
Stunted-overweight	Height-for-BMI (HBZ)	<-2 z-scores	.
Obese	BMI-for-age	>3 z-scores	.
Normal weight	BMI-for-age	=2 z-scores	.

Note: BMI is Body Mass Index. † derived using 2006 WHO's Zanthro Stata commands. ‡ represented the cut-off value recommended by WHO (1995).

The double anthropometric indicator of height-for-BMI (i.e., stunted-overweight to describe a child who was both stunted and overweight) was used. Children whose weight-for-age was below minus two standard deviations (-2SD) from the median of the recommended reference population were underweight (thinner for their age) (WHO 1995). Children whose height-for-BMI was below minus two standard deviations (-2SD) from the median of the recommended reference population were stunted-overweight (shorter for their weight). The new international reference population recommendations (i.e., prevalent thresholds) for wasting, overweight and stunting in children

under five years of age as established by the WHO-UNICEF Technical Advisory on Nutrition Monitoring (UNICEF, WHO, WBG 2021) were used as cut-off values. The prevalent threshold recommended by WHO (1995) was used for underweight.

Matching data were derived from propensity scores with similar control variables to address endogenous bias due to self-selection. In addition, household socioeconomic properties such as age, sex, literacy, educational attainment, household size, number of plots, cooperative membership, zone, and sector were some household socioeconomic used.

4.2 Statistical analysis

Statistical analysis was conducted using STATA 15.1 statistical software (StataCorp 2017). The mean, percentage, correlation, Chi^2, z-scores and t-test statistics were used for descriptive analysis. The households' mode of land acquisition and land right documentation and child anthropometric indicators were then fitted in the flexible panel difference-in-difference (*flexpaneldid*) model to study the effect of household land tenure on child malnutrition. Unlike the standard difference-in-difference method limited to two-period data and baseline information, *flexpaneldid* technique used multiple-period or panel data to address self-selection (no random assignment of land tenure indicators) and variable omission (time-in varying factors) biases. Thus, following Dettmann et al. (2020), the *flexpaneldid* can be expressed as:

$$DID^N = \left(A(t_{2018})|p(X) - C(t_{2018})|p(X)\right) - \left(A(t_{2015})|p(X) - C(t_{2015})|p(X)\right) - \left(A(t_{2012})|p(X) - C(t_{2012})|p(X)\right) = \delta_{2018} - \delta_{2015} - \delta_{2012} \quad \textit{Equation 1}$$

The $A(t_{2018/19})$ showed the child's nutritional outcome in the documented landholding unit at the final period. The $C(t_{2018/19})$ indicated child nutritional outcome in the non-documented landholding unit at 2018/19 of General Household Survey (GHS). The $A(t_{2012/13})$ and $A(t_{2015/16})$ represented child nutritional outcome of the documented landholding unit at the initial stages. The $C(t_{2012/13})$ and $C(t_{2015/16})$ denoted the child nutritional outcome of the non-documented landholding unit at the initial periods of 2012/13 and 2015/16 of GHS. The *flexpaneldid* technique adopted the initial surveys to select households that are not or in the process of acquiring land and documenting their land rights at different time periods. The selected households become documented and non-documented landholding units at the final period. The outcome variables DID^N were derived from Propensity Score Matching (PSM) (i.e., characterised with common support and conditional independence) to address the non-random selection bias for the counterfactual group. The *X* indicated the confounding factors (socioeconomic properties) that directly influence the mode of land acquisition and documentation of land rights at household levels, as shown in (Table 2).

A fixed-effect (FE) logistic regression model was used to provide a robust estimate of the effects beyond the mean difference estimate of the matched-based *flexpaneldid* model. In addition, the logistic regression model suggested by Vogl (2007) was used. As a result, the nutritional status *Y* of child *i* in household *h* at year *t*, can be given as:

$$Prob\,(Y_{iht} = 1|\theta_{ht}) = Y(\theta_{ht}, \varepsilon|H) = \frac{e^{\theta_{ht}}}{1 + e^{\theta_{ht}}} \qquad \textit{Equation 2}$$

The θ was the vector for the mode of land acquisition and land right documentation indicators of households *h* at year *t*, given *H* vector for household-head socioeconomic characteristics for matching analysis. The ε was the vector for the error term. If the mode of land acquisition and land right documentation indicators were recorded at the initial stage θ^i, children from tenure secure households at θ^t would be less likely to be stunted, wasted, underweight, overweight and stunted-overweight. Therefore, the maximum likelihood estimates of the response *Y* were derived from Equation 2. The present paper further compared the estimates of *flexpaneldid*-based FE logit from Equation 2 with the estimates of Average Treatment Effect (ATE) from Equation 1 before and after matching the data.

5. Results and Discussion

A summary of the dependent, independent and control variables is presented in Table 4. Just over half (52%) of the children were male. With an average age of less than three years old (29.46 months), the sampled children had an average weight of 12.81kg. The sampled children had an average of less than a meter height (88cm) and had own-child type of relation with the household heads. The average age of the household heads was 49 years old. Six (6) percent of the household heads were female. About 66 percent of the households were literate and held Junior Secondary School certificates. Most children and household heads were blood relatives. Some results of land rights are described in Table 4. About 51 percent of households had family-inherited land and 67

335 percent of households had the right to bequeath and use land as collateral. Landholders' variations
336 in the proportions of rights describe the differences in land-related documents to secure land rights
337 (tenure). Households (14%) who held informal land documents were slightly greater than the
338 holders of formal land certificates.

339

340 **Table 4:** Descriptive statistics with the variables used for analysis

Variable	Mean (Standard error)
Children characteristics	
Height	87.92 (19.84)
Weight	12.81 (5.48)
Age	29.46 (18.38)
Sex	0.48 (0.50)
Perceived land rights	
Right to sell	0.13 (0.34)
Rights to bequeath	0.67 (0.47)
Rights to fallow	0.06 (0.23)
Rights to use land collateral	0.67 (0.47)
Mode of land acquisition indicators	
Family-inheritance	0.51 (0.50)
Outright purchased	0.14 (0.35)
Community distribution	0.28 (0.45)
Used land free of charge	0.16 (0.37)
Rented land	0.11 (0.31)
Land right documentation indicators	
Formal land certificate	0.11 (0.31)
Informal land documents	0.14 (0.35)
Household characteristics	
Age	48.96 (12.56)
Sex	0.06 (0.23)
Literate	0.66 (0.47)
Educational attainment	5.06 (4.79)
Household size	8.29 (3.68)
Number of plots	2.53 (1.56)
Household-head's relationship with a child	3.33 (1.10)
Cooperative membership	0.08 (0.27)
Zone	3.19 (1.62)

Sector	0.75 (0.43)

Source: Authors, (2021)

Table 5 presents the mean difference in land right documentation across households' modes of land acquisition. A significant proportion of the purchased landholders held formal land certificates and informal land documents. The results revealed that purchased land facilitated demand for land rights documentation more than any other modes of land acquisition. A few users of free land held formal land certificates and informal land documents. A low proportion of rented landholders owned informal land documents. More holders of community-distributed land had no formal land certificates or informal land documents. The results implied that the lack of formal land titles by community-distributed landholders might hinder the potential for land use as collateral to acquire credits. Inherited landholders obtained informal land documents to secure land rights rather than formal land certificates. Holders of inherited land had a stronger sense of informal (*de facto*) tenure security, limiting their demand for formal land certificates.

Table 5: Mean of land right documentation indicators by mode of land acquisition among smallholders

Mode of land acquisition	Land right documentation indicator	
	Formal land certificates	Informal land documents
Purchased land	0.53 (0.03)	0.38 (0.03)
No purchased land	0.04 (0.01)	0.10 (0.01)
Mean difference	0.49*** (0.01)	0.28*** (0.02)
Inherited land	0.13 (0.01)	0.21 (0.01)
No inherited land	0.09 (0.01)	0.07 (0.01)
Mean difference	0.04*** (0.01)	0.14*** (0.02)
Community distributed land	0.03 (0.01)	0.03 (0.01)

No community distributed land	0.14 (0.01)	0.19 (0.01)
Mean difference	-0.12*** (0.02)	-0.15*** (0.02)
Used land free of charge	0.07 (0.02)	0.08 (0.02)
Don't used land free of charge	0.12 (0.01)	0.15 (0.01)
Mean difference	-0.05** (0.02)	-0.07*** (0.02)
Rented land	0.13 (0.02)	0.10 (0.02)
No rented	0.11 (0.01)	0.15 (0.01)
Mean difference	0.02 (0.02)	-0.05** (0.03)
Observation	1815	1815

Standard error in parentheses, Significant level: ***p<0.01, **p<0.05, *p<0.1

Source: Authors, (2021)

Figure 2 presents the distribution of z-scores for child anthropometry expressed in the normal population distribution of the sampled children. The histogram bars of anthropometric data for height-for-age followed the fitted line of the normal distribution with zero means of z-score. The diagrams for weight-for-age, weight-for-height, and height-overweight illustrated the spread of values for the child anthropometry indicators clustered around the WHO standard z-scores thresholds (i.e., z-scores < -2). The histogram bars of the child anthropometrics followed the probability distribution function for the sampled population. The BMI-for-age indicator had few observations and its data clustered negatively away from the WHO standard mean for BMI-for-age z-scores (z-scores > +2).

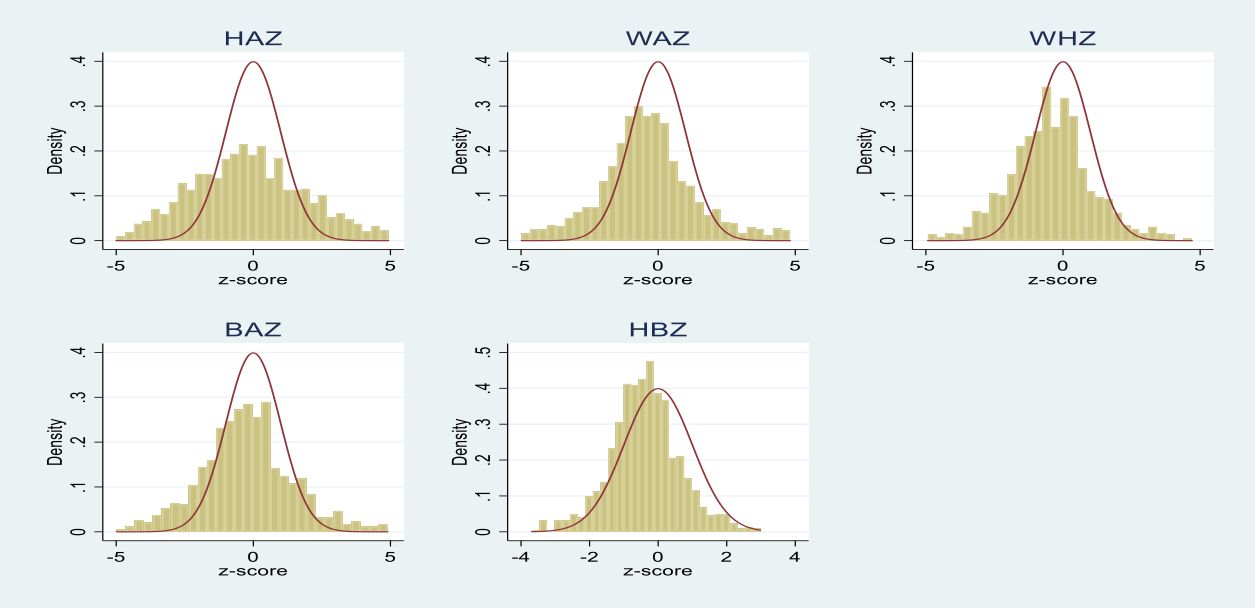


Figure 2: Distribution of z-scores between 2012 and 2018 in Nigeria
Source: Authors, (2021)

Figure 3 illustrates the relationship between the anthropometric indicators from 2012 to 2018 in Nigeria. There was no correlation between weight-for-height and height-for-age z-scores or between height-for-age and BMI-for-age z-scores. The result showed the possibility of having underweight (weight-for-age z-score <-2) and stunted-overweight (height-for-BMI z-score<-2) children.

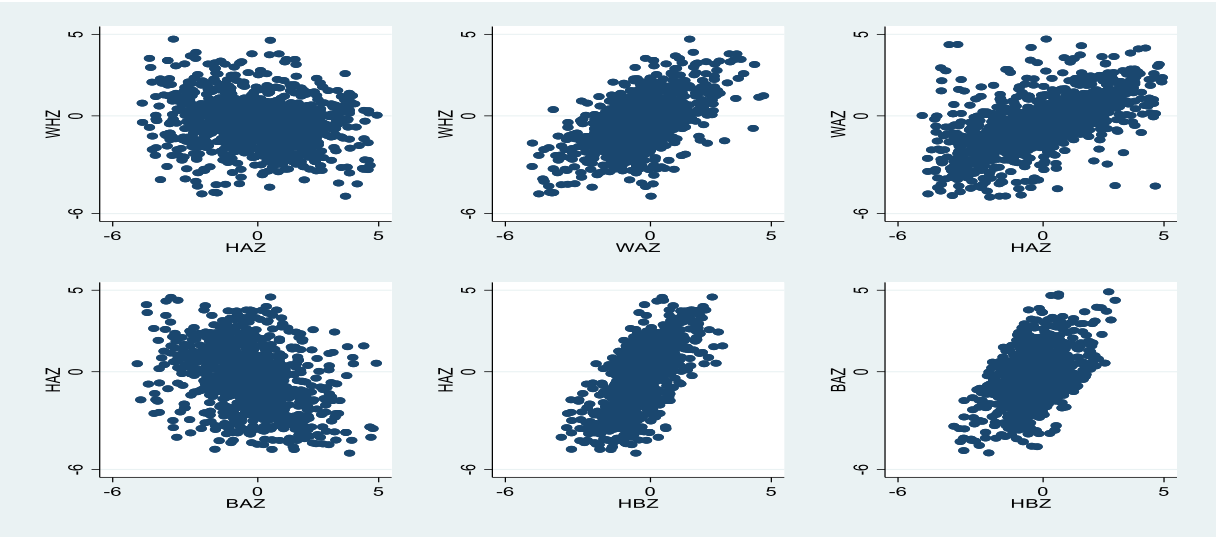


Figure 3: Correlation between different child anthropometric indicators between 2012 and 2018 in Nigeria
Source: Authors, (2021)

Table 6 presents the summary statistics for the incidence of child malnutrition between 2012 and 2018 in Nigeria. As shown in Table 6, eight percent of children were overweight. Twenty percent of children were stunted and 14 percent of children were wasted. These proportions of stunted and wasted children were classified as high levels of malnutrition according to UNICEF, WHO, WBG (2021). Overweight children were within the median reference range. Fourteen percent of children were underweighted for their age, whereas 15 percent suffered from stunting and overweight. Approximately fourteen (14.13) percent of sampled children was underweight. This proportion was classified within a medium prevalence (10-19) of underweight following WHO, (1995) reference in Table 3. About 1.59 percent of children were severely overweight. Except for severely wasted children (2.17), the proportion of severely stunted (4.58) and underweight (3.43) children was below the national average in 2018 and 2021 (Figure 1).

Table 6: Descriptive summary of child anthropometric indicators

Anthropometry	N	Mean	SD	% Below -2 S.D.	% Below -3SD
HAZ	1321	-0.17	2.03	19.91	4.58
WHZ	1098	-0.45	1.50	14.21	2.17
WAZ	1394	-0.38	1.71	14.13	3.43
HBZ	1003	-0.38	1.01	3.79	
Anthropometry	N	Mean	SD	% Above 2 S.D.	
BAZ	1047	-0.25	1.65	8.31	1.59

Note: SD means standard deviation, n is total observed samples and % represents the percentage
Source: Authors, (2021)

Table 7 presents the child demographic characteristics by BMI categories. There were significant differences in the distribution BMI category for gender ($p<0.05$), sector ($p<0.01$) and zone

403 (p<0.01). Female children were more overweight (11%) and obese (9%) than male children. North-
404 Central zone had the highest proportion (14%) of overweight and obese children. While more
405 overweight children were found in rural areas (10%), obese children (12%) were more prevalent
406 in urban areas. The incidence of overweight children in the rural sector can be attributed to high-
407 calorie intake from staple foods (Bishwajit 2015). At the same time, the consumption of junk and
408 processed foods rich in sugar and salts is more likely responsible for child obesity in urban areas
409 (Bishwajit 2015).

410

411 **Table 7**: Proportion (%) of child BMI category by child demographic characteristics

Characteristics	Group	Normal weight	Overweight	Obese	N	Pearson Chi2 (p-value)
Gender	Male	0.86	0.08	0.06	590	7.76** (0.02)
	Female	0.80	0.11	0.09	510	
Sector	Rural	0.83	0.10	0.07	827	12.46*** (0.00)
	Urban	0.83	0.05	0.12	273	
Zone	North-Central	0.72	0.14	0.14	197	40.54*** (0.00)
	North-East	0.80	0.12	0.09	223	
	North-West	0.83	0.10	0.07	296	
	South-East	0.92	0.04	0.04	125	
	South-South	0.94	0.04	0.02	140	
	South-West	0.86	0.05	0.09	119	
Year	2012	0.85	0.09	0.05	358	5.43 (0.25)
	2015	0.83	0.08	0.09	458	
	2018	0.81	0.10	0.09	284	
Child Relationship to Households	Own child	0.82	0.10	0.08	972	7.45 (0.92)
	Stepchild	0.86	0	0.14	7	
	Adopted child	0.80	0.20	0	5	
	Grandchild	0.88	0.07	0.05	10.3	
	Brother/Sister	0.80	0	0.20	5	
	Niece/Nephew	0.83	0	0.17	6	
	Brother/Sister In-law	1	0	0	1	
	Other Relation	1	0	0	1	
	Combined	0.83	0.09	0.08	1100	
	N	913	101	86	1100	

412 Significant level: ***p<0.01, **p<0.05, *p<0.1
413 Source: Authors, (2021)

414

415 Table 8 summarises the statistics of child anthropometry across child demographic characteristics.
416 Although sex differences in child anthropometric indicators were not statistically significant at the
417 5 percent level of significance, stunting (21%) and underweight (15%) were more prevalent among
418 male children. On the other hand, more female children were overweight (10%), wasted (15%)
419 and stunted for their BMI (19%). As normal-weight children declined by two percent from 2012
420 to 2018 in Nigeria, a slight increase in overweight and obese children occurred from 2012 to 2018
421 (Table 7).

422

423 There were significant differences ($p \leq 0.05$) in the rates of child stunting, underweight and stunted-
424 overweight between rural and urban sectors. The rural sector had 22 percent stunted and
425 underweight children, while 28 percent of urban children suffered from both stunting and
426 overweight. The zones differences in stunting, wasting and overweight were also statistically
427 significant ($p \leq 0.05$). Stunted and underweight children were more prevalent in the North-East and
428 North-West, while North-Central took the lead in having overweight and stunted-overweight
429 children. About 30 percent of stunted children resided in the North-West zone, 19 percent of
430 wasted children were in the South-West zone. Twenty percent and 26 percent of children were
431 underweight and stunted-overweight in the North-Central. As the underweight and overweight
432 children of sampled smallholders decreased from 2012 to 2018, the stunted children of sampled
433 smallholders increased from 2012 to 2018.

434

Table 8: Descriptive statistics of child anthropometry by child demographic characteristics

Characteristic	Group	HAZ<-2	WHZ<-2	WAZ<-2	BAZ>2	HBZ<-2
Gender	Male	0.21	0.14	0.15	0.07	0.12
	Female	0.18	0.15	0.14	0.10	0.19
	Pearson Chi2 (p-value)	0.52 (0.47)	0.17 (0.68)	0.35 (0.56)	2.86* (0.09)	2.73* (0.10)
Sector	Rural	0.22	0.14	0.16	0.08	0.13
	Urban	0.13	0.14	0.09	0.10	0.28
	Pearson Chi2 (p-value)	13.13*** (0.00)	0.03 (0.86)	10.02*** (0.00)	1.25 (0.26)	6.06*** (0.01)
Zone	North-Central	0.18	0.12	0.11	0.14	0.26
	North-East	0.26	0.11	0.17	0.10	0.14
	North-West	0.30	0.17	0.20	0.08	0.14
	South-East	0.07	0.10	0.06	0.03	0.10
	South-South	0.09	0.15	0.11	0.03	0.08
	South-West	0.10	0.19	0.12	0.06	0
	Pearson Chi2 (p-value)	66.16*** (0.00)	9.15* (0.10)	25.14*** (0.00)	20.28*** (0.00)	7.51 (0.19)
Year	2012	0.13	0.14	0.09	0.06	0.13
	2015	0.22	0.14	0.16	0.10	0.16
	2018	0.24	0.15	0.18	0.08	0.16
	Pearson Chi2 (p-value)	18.15*** (0.00)	0.45 (0.80)	17.00*** (0.00)	5.23* (0.07)	0.33 (0.85)
Relationship to HH	Own Child	0.21	0.14	0.14	0.08	0.15
	Stepchild	0.14	0.33	0.14	0.17	1
	Adopted child	0.14	0	0.14	0.25	1
	Grandchild	0.13	0.17	0.11	0.06	0.56
	Brother/Sister	0.25	0	0.20	0.20	0
	Niece/Nephew	0.33	0.33	0.17	0.17	0.50
	Pearson Chi2 (p-value)	6.62 (0.58)	5.79 (0.56)	1.68 (0.99)	4.39 (0.73)	14.52*** (0.01)
	Combined	0.20	0.14	0.14	0.08	0.04
	N	263	156	197	87	38

Significant level: ***p<0.01, **p<0.05, *p<0.1

Source: Authors, (2021)

The relationship of the child to the household head influences a child's nutritional status. Children who had a brother/sister (20%), niece/nephew (17%) and stepchild (14%) relation to the household head were more likely obese than children (8%) of the household heads. Adopted children (12%)

were two percent more in overweight than children of the household heads (10%). More than half of the stunted and overweight children were the household head's grandchild and niece/nephew.

Table 9 presents the descriptive summary of the mode of land acquisition by household demographic characteristics. The findings revealed no significant results for gender in the households that acquired land through purchase, family inheritance, community distribution and renting. However, more male households acquired land free of charge than female household heads. The urban households (significantly) held purchased and rented land more than the rural households. Rural households had more land than urban households through family inheritance and community distribution mode of land acquisition.

There were significant variations in the land acquisition mode across the zones in Nigeria. Households that held land via purchase and free of charge (for abandoned land) were significantly more prevalent in the South-West. In contrast, more than half of sampled households held inherited land in North-Central, North-East, North-West and South-East zones of Nigeria. More than one-fifth of households held land in the North-Central (24%), North-East (38%), North-West (24%), South-East (35%) and South-South (21%) through community distribution. More households held land free and rented in the South-West (31%) and South-South (27%). Households held more land through purchases (25%), inheritance (72%) and renting (15%) in the year 2018 compared to the subsequent years of data collection. The incidence of tenants was prevalent in the South-South. About 10 percent households held more land free in 2015, while 72 percent and 15 percent held land through inheritance and rent in 2015 and 2018, respectively.

464 **Table 9:** Descriptive statistics of the mode of land acquisition by household demographic characteristics

Characteristic	Group	Purchased land	Inherited land	Community distributed land	Free use land	Rented land	Observation
Gender	Male	0.14	0.51	0.28	0.16	0.11	1712
	Female	0.09	0.49	0.29	0.09	0.13	103
	Pearson Chi2 (p-value)	2.42 (0.12)	0.33 (0.57)	0.09 (0.76)	4.16 (0.04)	0.31 (0.58)	
Sector	Rural	0.12	0.53	0.30	0.15	0.10	195
	Urban	0.31	0.34	0.13	0.22	0.23	1620
	Pearson Chi2 (p-value)	55.31*** (0.00)	25.08*** (0.00)	22.84*** (0.00)	5.26** (0.02)	32.84*** (0.00)	
Zone	North-Central	0.06	0.51	0.24	0.18	0.07	310
	North-East	0.11	0.53	0.38	0.15	0.09	447
	North-West	0.21	0.52	0.24	0.15	0.08	505
	South-East	0.03	0.58	0.35	0.08	0.09	243
	South-South	0.18	0.48	0.21	0.19	0.27	219
	South-West	0.35	0.33	0.13	0.31	0.16	91
	Pearson Chi2 (p-value)	101.53*** (0.00)	17.46*** (0.00)	50.77*** (0.00)	29.32*** (0.00)	76.04*** (0.00)	
Year	2012	0.06	0.03	0.75	0.06	0.09	551
	2015	0.08	0.72	0.07	0.10	0.07	567
	2018	0.25	0.72	0.07	0.08	0.15	697
	Pearson Chi2 (p-value)	123.52*** (0.00)	741.59*** (0.00)	881.93*** (0.00)	0.26 (0.88)	23.49*** (0.00)	

465 Significant level: ***p<0.01, **p<0.05, *p<0.1

466 Source: Authors, (2021)

Table 10 presents the descriptive summary of land rights documentation of household demographic characteristics. Male households held more formal land certificates and informal land documents than the female household heads. More urban households had formal land certificates and informal land documents than rural households. This result could be due to the relatively high prevalence of land market transactions in the urban areas. Across the southern zones, households held more informal land documents than formal land certificates. Acquisition of land-related documents remains lower and unchanged in the Northern zones. More household heads held formal land certificates in 2018 and informal land documents in 2015. Only three percent of household heads had land-related documents in 2012, despite the implementaiton of Nigeria's 2009 land reform programme. The programme's purpose was to encourage formal land certificates but rather supported leasehold rights over customary freehold rights that were abolished by 1978 LUA (Hall et al., 2019).

Table 10: Descriptive statistics of documentation of land rights indicators by household demographic characteristics

Characteristics	Group	Formal land certificate	Informal land documents	Observation
Gender	Male	0.12	0.15	1712
	Female	0.03	0.07	103
	Pearson Chi2 (p-value)	7.39*** (0.01)	5.04** (0.03)	
Sector	Rural	0.09	0.13	1620
	Urban	0.25	0.24	195
	Pearson Chi2 (p-value)	43.82*** (0.00)	15.28*** (0.00)	
Zone	North-Central	0.08	0.12	310
	North-East	0.11	0.11	447
	North-West	0.16	0.16	505
	South-East	0.03	0.86	243
	South-South	0.12	0.21	219
	South-West	0.14	0.30	91
	Pearson Chi2	34.42***	39.15***	

	(p-value)	(0.00)	(0.00)	
Year	2012	0.03	0.03	551
	2015	0.08	0.24	567
	2018	0.20	0.15	697
	Pearson Chi2 (p-value)	105.12*** (0.00)	105.92*** (0.00)	

Significant level: ***p<0.01, **p<0.05, *p<0.1
Source: Authors, (2021)

Table 11 shows the age-specific summary of sampled children across household head-children relation types. The average age of sampled children was less than three years old. Most (88%) of the sampled children were averagely less than three years old and had own-child type of relation with the household heads.

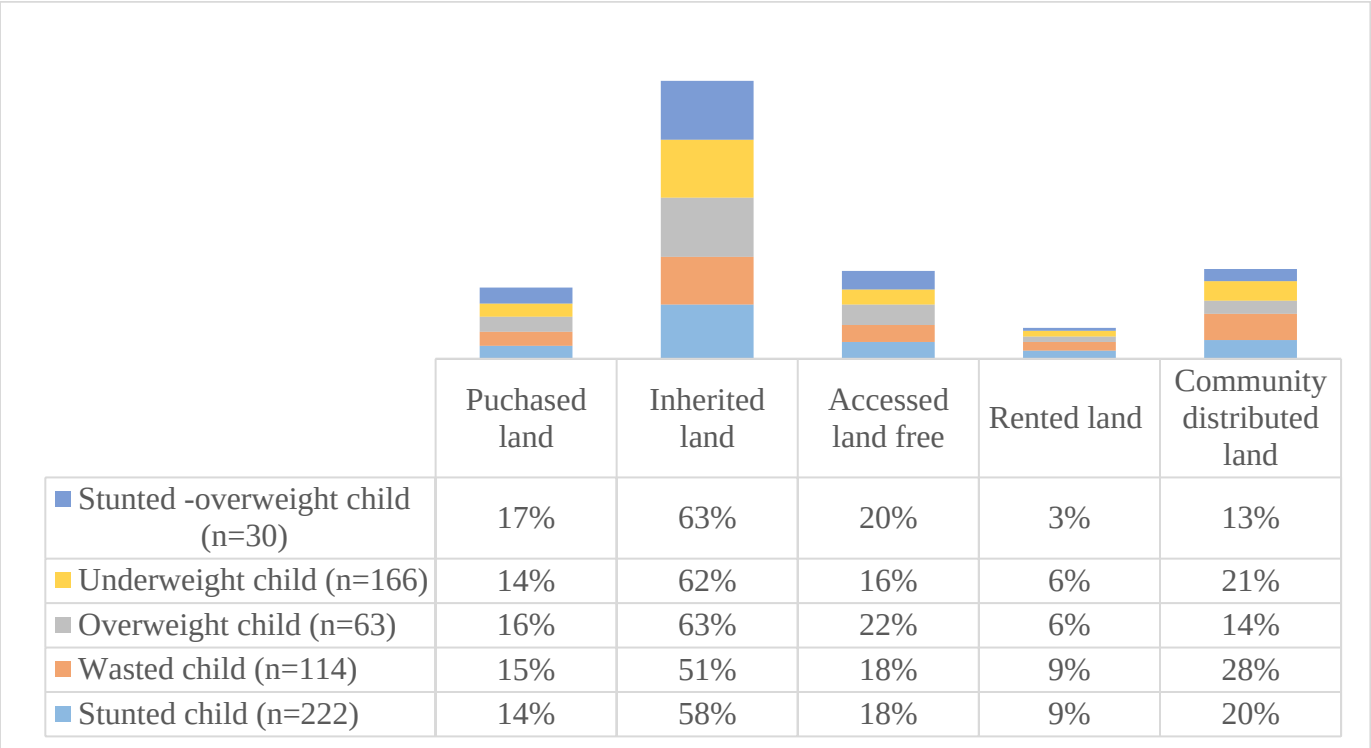
Table 11: Mean age of children by their relationship with household-heads

Relationship to Household-heads	Mean age (years)	N	%
Own child	2.48	1473	88
Stepchild	3.33	9	0.50
Adopted child	2.86	7	0.40
Grandchild	2.34	161	10
Brother/Sister	2.86	7	0.40
Niece/Nephew	3.13	8	0.50
Brother/Sister in-law	5.00	1	0.06
Other Relation	3.00	1	0.06
Other Non-relation	1.00	2	0.10
Combined	2.88	1669	100

Source: Authors, (2021)

Figure 4 illustrates the percentage of malnourished children by smallholders' mode of land acquisition. Although purchased landholders as one of the owned landholder indicators had less than 20 percent malnourished children, children in households that acquired inherited land were more likely to be malnourished. Households with inherited land had more than 50 percent of the

malnourished children measured by stunting (58%), wasting (51%), underweight (62%), overweight (62%) and stunted-overweight (63%) indicators. The results suggested that family conflicts may affect inherited landholders to improve farmland for productive or nutrition-sensitive agriculture that enhances food security and nutrition. Households who acquired land through community distribution, renting or free of charge had less than 30 percent malnourished children. Fewer than 10 percent of malnourished children were found in households with secure access to rented land.

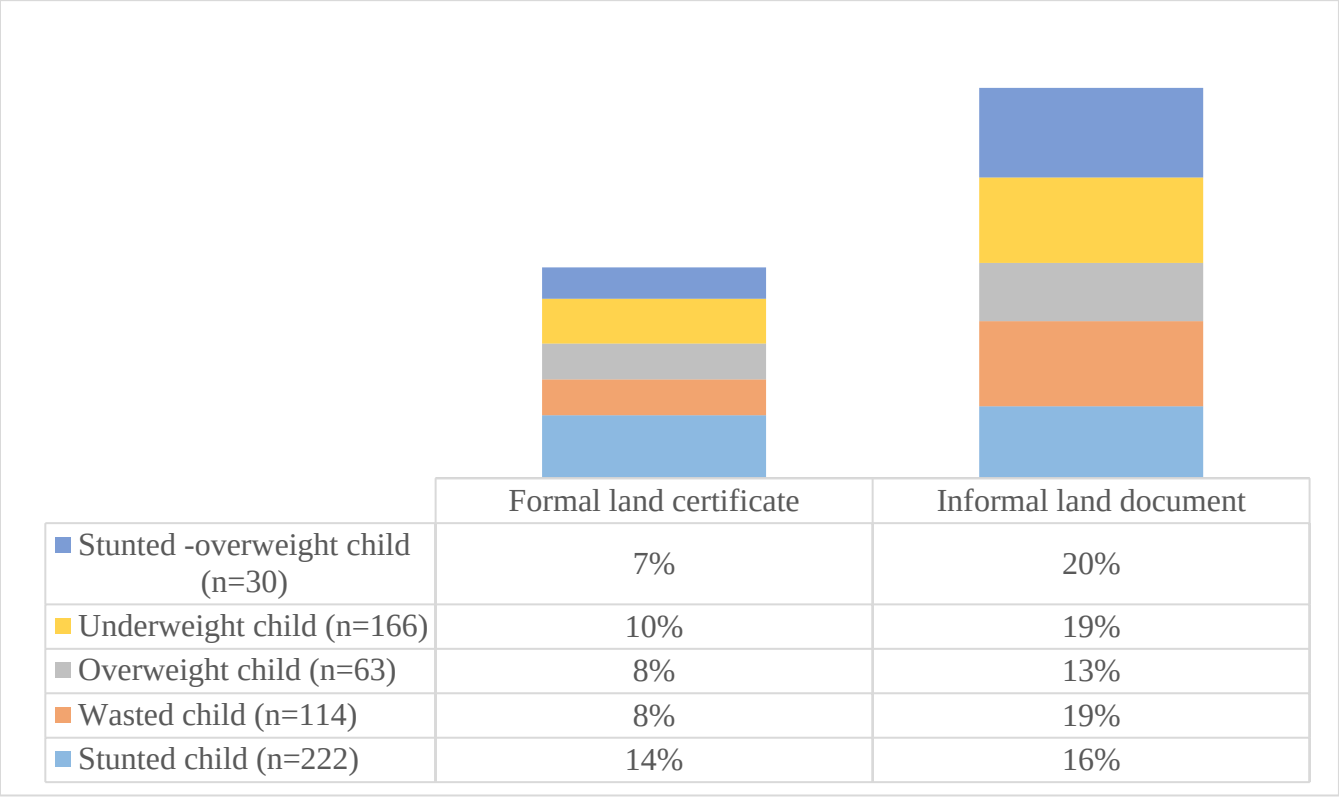


	Puchased land	Inherited land	Accessed land free	Rented land	Community distributed land
Stunted -overweight child (n=30)	17%	63%	20%	3%	13%
Underweight child (n=166)	14%	62%	16%	6%	21%
Overweight child (n=63)	16%	63%	22%	6%	14%
Wasted child (n=114)	15%	51%	18%	9%	28%
Stunted child (n=222)	14%	58%	18%	9%	20%

Figure 4: Percentage of malnourished children by smallholders' mode of land acquisition
Source: Authors, (2021)

Figure 5 illustrates the proportion of malnourished children by smallholders' land right documentation type. Fewer than 21 percent of the undernourished children lived in households

holding formal land certificates or informal land documents. Child malnutrition rates were low among households with formal or informal land documents to secure their land rights. The results implied that households with formal land certificates could use their land as collateral to acquire a formal loan that enhances farm investments and improves food security and child health. However, obtaining the formal land certificate might be challenging due to the high cost of land titling and bureaucratic processes, which influence the demand for more informal land documents.



	Formal land certificate	Informal land document
Stunted -overweight child (n=30)	7%	20%
Underweight child (n=166)	10%	19%
Overweight child (n=63)	8%	13%
Wasted child (n=114)	8%	19%
Stunted child (n=222)	14%	16%

Figure 5: Percentage of malnourished children by smallholders' land right documentation indicators
Source: Authors, (2021)

The results of the household land acquisition type affecting child malnutrition are presented in Table A1. There were no significant Average Treatment Effect (ATE) coefficients of rented land before and after matching observations for the effects of rented land on child malnutrition.

Statistical inferences were also not made for the fixed-effect model's non-significant estimates of rented land. However, the ATE estimates before matching revealed that more stunted, underweight and stunted-overweight children were associated with households that owned inherited land. After sample matching, the ATE estimates of inherited land suggested that wasted and overweight children were more likely to be found in households with inherited land. Although there were no significant coefficients of inherited land fitted in the fixed-effect model, the ATE results indicated that children in households that acquired an inherited land were more prone to malnourishment. The results implied that improving smallholder child nutrition is less likely when households on inherited farmlands lack well-defined property rights and experience family land conflict, leading to insecurity.

The ATE coefficients of community-distributed land before matching were negative and significant to explain child malnutrition. The results implied that households with community-distributed land were eight percent, five percent less likely to have stunted, underweight and overweight children, respectively. While the Fixed Effect (FE) and ATE estimates after matching observations were not statistically significant, the estimates of community-distributed landholders before matching had a greater impact on reducing child malnutrition. These results relied on the possibility that individual use of community-distributed land provides a sense of *de facto* tenure security due to the existing customary norms and networks that protect land rights and entitlements (Hall et al. 2019). After matching observations, the ATE coefficients for free land access for overweight outcomes were positively significant ($p<0.1$), meaning that overweight children were more likely to be found in households who had accessed free land. The ATE estimates before matching observations and FE coefficients of free land access were not statistically significant. As

548 with the results of the effect of rented land, there were no significant coefficients of purchased land
549 to determine child malnutrition.
550
551 The results of the land right documentation affecting child malnutrition are presented in Table A2.
552 While the FE and ATE coefficients of formal land certificates on child malnutrition after matching
553 observations were not statistically significant, the ATE estimate of holding a formal certificate
554 before matching observations were significant at one percent for households with stunted children.
555 The significant result indicated that households that held formal land certificates were more likely
556 to have stunted children. The result was consistent with *apriori* expectations. Similar results were
557 reported by Kehinde et al. (2021) and Vogl (2007) that found formal titling did not improve
558 household food security in Nigeria and height-for-age of children in Peru, respectively. Binding
559 land right alienation (rent, mortgage or sales) with prior consent or approval of government and
560 ceiling lease landholding to 99 years may limit the private welfare benefits of formal land
561 documentation in Nigeria. Political instabilty may institute poor land governance, jeopidising the
562 fair compensation defined under 1978 LUA for revoked land rights. These clauses disincentivise
563 long-term farm investment decisions and reduce the likelihood of land being used as collateral for
564 formal loan acquisitions. The ATE coefficient of informal land documents before matching
565 observations was significant at 10 percent for child wasting and underweight. The ATE and FE
566 model coefficients of informal land documents after matching observations were negative and
567 statistically significant for child wasting and overweight. The results implied that households who
568 held informal land documents were respectively seven percent and five percent less likely to have
569 wasted and overweight children, respectively. Galiani & Schargrodsky (2004) and Vogl (2007)
570 found the same results for formal titling studies in urban Argentina and Peru.

6. Conclusion and Recommendations

The results showed that households who held rented and purchased land did not have a significant number of malnourished children. Family-inherited and free landholders were more likely to have stunted, underweight, overweight and stunted-overweight children. Households that held community-distributed land were less likely to have stunted, overweight and underweight children. The findings suggest that community land allocation interventions may provide households with small children with easy access to farmlands and promote child nutritional outcomes.

While the formal land certificate holders had 13 percent chance to have stunted children, the holders of informal documents were seven percent and five percent less likely to have wasted and overweight children. The results suggested that smallholder land tenure had a small but relevant effect on improved child nutrition. Formal recognition of community-level land distribution and informal land documents have policy implications for improving individual nutrition in farming households. The findings suggests that strengthening land rights and entitlements of smallholder farmers can facilitate land dispute resolution, access to formal loans and investment in inputs to support socioeconomic security and nutrition-sensitive agriculture that improves child nutrition. Government and relevant stakeholders should lobby for the reform of 1978 LUA to ease land acquisition and formalise informal land documents to enhance land rights and entitlements of smallholder farmers.

The study has some limitations. First, while our research findings were based on a flexible quasi-experimental analysis, many confounding and mediating factors related to socioeconomic characteristics and food security dimensions were not accounted for, limiting the causal pathways explanations and identification strategy of this study. Yet, the present study exploited available panel data and provided the first empirical evidence that revealed the variations in child malnutrition indicators across the mode of land acquisition and land tenure documentation in Nigeria. Future research should revisit the natural experiment approach to address the selection issues and validate the pathways of (how) the land tenure elements considered in this paper could affect nutrition using Structural Equation Modeling (SEM) framework. Second, our descriptive results showed variations of child nutritional outcomes, mode of land acquisition and land rights documentation in gender, sector (rural and urban areas) and zonal differences. Future research should investigate how these demographic characteristics could affect the relationship between smallholder land tenure and child nutrition. Finally, although smallholder farmers always depend on agriculture to enhance nutritional status, the context of land tenure systems of a country is important to understand the role of smallholder land tenure on child nutritional outcomes. The study explored the context of Nigeria's smallholder land tenure administrations. However, the findings would be relevant to African countries with similar land tenure systems, ripped for reform to support the national agricultural policy. Future research can explore nutritional status under different land tenure settings in Africa.

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764 **Table A1:** The *Flexpaneldid*-FE results of the effect of land acquisition on child nutritional status

Mode of land acquisition	Model	Stunted child	Wasted child	Overweight child	Underweight child	Stunted-overweight child	Matching	Fixed Effect
Rented land	1	0.03 (0.04)	0.02 (0.04)	-0.03 (0.03)	-0.06 (0.04)	0.03 (0.02)	No	No
	n	995	807	781	1047	749		
	2	-0.03 (0.05)	-0.02 (0.05)	0.03 (0.04)	0.03 (0.03)	-0.01 (0.02)	Yes	No
	n	288	224	305	205	191		
	3	-0.43 (1.09)	3.91e-17 (1.42)	-1.45 (1.47)	#	#	Yes	Yes
	n	89	45	85	17	4		
Inherited land	1	0.06** (0.03)	0.003 (0.02)	0.03 (0.02)	0.07*** (0.02)	0.02** (0.01)	No	No
	n	995	807	781	1,047	749		
	2	0.03 (0.04)	0.05* (0.03)	0.06** (0.03)	0.02 (0.03)	-0.02 (0.02)	Yes	No
	n	857	622	935	606	560		
	3	0.63 (0.79)	0.80 (1.26)	16.50 (1239.39)	16.06 (2.96e03)	#	Yes	Yes
	n	296	133	268	74	33		
Community-distributed land	1	-0.08*** (0.03)	-0.00 (0.03)	-0.05*** (0.02)	-0.05* (0.03)	-0.03 (0.02)	No	No
	n	995	807	781	1047	749		
	2	-0.02 (0.04)	0.06 (0.04)	0.02 (0.03)	-0.01 (0.03)	-9.72e-04 (0.02)	Yes	No
	n	624	485	677	409	386		
	3	-0.11 (0.74)	5.40 (11.98)	0.36 (0.67)	1.10 (1.53)	#	Yes	Yes
	n	120	70	118	36	14		
Used land free of charge	1	-0.003 (0.03)	0.002 (0.03)	0.03 (0.03)	-0.02 (0.03)	0.01 (0.02)	No	No
	n	995	807	781	1047	749		

	2	0.03 (0.04)	0.03 (0.03)	0.05* (0.03)	0.03 (0.03)	0.02 (0.02)	Yes	No
	n	500	358	536	331	216		
	3	-0.64 (0.79)	-1.03 (1.18)	-0.35 (0.80)	-16.60 (2248.35)	# 	Yes	Yes
	n	136	57	114	37	11		
Purchased land	1	0.03 (0.04)	0.04 (0.04)	0.03 (0.03)	0.02 (0.03)	0.02 (0.02)	No	No
	n	995	807	781	1047	749		
	2	0.02 (0.04)	0.03 (0.04)	0.01 (0.04)	-1.83e-03 (0.04)	-0.00 (0.02)	Yes	No
	n	374	272	398	263	246		
	3	0.16 (1.34)	-0.87 (1.72)	-0.71 (1.27)	1.39 (1.73)	# 	Yes	Yes
	n	118	59	122	33	7		

765 Note: n represents the number of observations in each model of the analysis. # signifies incomplete results due to unvaried outcomes or
766 low observation. Standard error in parentheses, Significant level: ***p<0.01, **p<0.05, *p<0.1
767 Source: Authors, (2021)
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Table A2: The Flexpaneldid-FE regression results of the effect of land right documentation on child nutritional status

Land right documentation Indicator	Model	Stunted child	Wasted child	Overweight child	Underweight child	Stunted-overweight child	Matching	Fixed Effect
Formal land certificate	1	0.13*** (0.05)	-0.01 (0.04)	-0.01 (0.03)	0.02 (0.04)	-0.01 (0.03)	No	No
	n	995	807	781	1047	749		
	2	0.02 (0.05)	-0.02 (0.04)	-0.03 (0.04)	0.02 (0.04)	-0.00 (0.02)	Yes	No
	n	295	209	320	205	191		
	3	-1.14 (1.05)	-1.38 (1.73)	-1.34 (1.33)	-0.18 (1.95)	#	Yes	Yes
	n	116	40	103	24	2		
Informal land documents	1	0.03 (0.04)	0.05* (0.03)	0.02 (0.03)	0.05* (0.03)	0.02 (0.02)	No	No
	n	995	807	781	1047	749		
	2	0.00 (0.04)	-0.07* (0.04)	0.02 (0.03)	-0.01 (0.03)	0.01 (0.02)	Yes	No
	n	443	331	475	319	287		
	3	0.06 (0.85)	0.87 (1.36)	-1.95** (0.93)	3.87e-05 (1.73)	#	Yes	Yes
	n	134	65	138	32	14		

Note: n represents the number of observations in each model of the analysis. # Signifies omission of results due to unvaried outcomes or low observation. Standard error in parentheses, Significant level: ***p<0.01, **p<0.05, *p<0.1

Source: Authors, (2021)