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Energy access, entrepreneurship and gender dynamics in food security in Sub-Saharan Africa

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Abstract
This study delves into the intricate interplay of gender dynamics within the realms of food security, energy access, and entrepreneurship in Sub-Saharan Africa (SSA). Through a comprehensive analysis, it seeks to uncover the unique challenges and opportunities faced by women and men in these critical sectors. Data for the study was obtained from the Food and Agricultural Organization (FAO) and World Development Indicators (WDI). The system Generalized Method of Moments (SGMM) was used for the analysis. Results show that women entrepreneurs face unique challenges in accessing resources and markets, which can impact their ability to contribute to food security. Additionally, the study highlights the importance of gender-sensitive policies and programs that support women entrepreneurs in the food sector.

Keywords Energy access · Entrepreneurship · Food security · Cross-gender analysis · Sustainable development

1 Introduction

In Sub-Saharan Africa (SSA), the intersections of gender, food security, energy access, and entrepreneurship present a complex landscape that shapes individuals' opportunities and challenges [1, 2]. This study delves into the intricate web of gender dynamics within these crucial sectors, aiming to uncover the unique experiences of women and men as they navigate issues of access, participation, and empowerment. By examining the ways in which gender norms, roles, and power dynamics influence individuals' engagement with food security, energy access, and entrepreneurship, this research seeks to shed light on the disparities and opportunities that exist in Sub-Saharan Africa. Through a comprehensive analysis, this study aims to inform more inclusive and equitable policies and interventions that can enhance the livelihoods and well-being of all individuals in the region.

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Furthermore, the study aims to understand how access to reliable and affordable energy sources influences individuals' ability to secure an adequate and nutritious food supply. This was done by exploring the relationship between energy access and food security and seeking to identify the barriers and opportunities that exist in this context. Also, the study focuses on understanding how engagement in entrepreneurial activities affects individuals' food security outcomes. By examining the role of entrepreneurship in shaping access to food, income generation, and economic empowerment, the study would uncover the potential benefits and challenges associated with entrepreneurial ventures in the region. Likewise, the study seeks to explore how gender dynamics intersect with issues of energy access, entrepreneurship, and food security in Sub-Saharan Africa. By analysing the unique experiences of women and men in relation to these key sectors, the study aims to uncover disparities, inequalities, and opportunities that exist based on gender. Through a gender-sensitive lens, the research aims to highlight the importance of addressing gender-specific barriers and promoting gender equality in efforts to enhance food security, energy access, and entrepreneurship in the region.

In SSA, the connect of gender dynamics with critical sectors such as food security, energy access), and entrepreneurship [3] is increasingly recognized as pivotal to sustainable development. Understanding these dynamics is essential for addressing the pervasive inequalities that affect women and men differently in their access to resources, opportunities, and decision-making power. African women under reproductive age are very versatile in agriculture and entrepreneurship which if harnessed goes a long away in contributing to their food security [4–8]. Either as a result of wrong policy formulations, cultural background, or gender biasness in the society, majority of them have been marginalized. In the opinion of [9] there is a dividing line of gender time-related stress due to child bearing care, which makes them try to balance the role of earning and care giving at the same time. In some African countries, culture inhibits women from entrepreneurial activities.

A case in point is the labour market outcome of Australian mothers which are impaired as a result of the fragile balancing of commitment between motherhood and work, resulting from culture [10]. Report also has it that, a typical Australian mother of infant spends 51 h per week providing care and 25 h on housework which greatly reduce their capacity for paid work [11]. In addition, only16.5% are in full-time employment with an additional 41.2% in part-time employment [12] Stressing the point further, [13] according to research found that among partnered Australians working mothers, 45% work part-time. This lost opportunity posed by the unused human capital of Australian women is about $300 billion per year [14].

These factors sometimes make reproductive women (mothers) being perceived as unemployable by both themselves and employers of labour, with the great consequence of stagnation [15]. Resultantly, the disadvantages faced by women, due to their responsibilities as care givers, have left them with the options of taking up self-employment, in the areas of home-based businesses [16]. Looking at this from another view, it could also be referred to as non-inclusiveness. [17] explained inclusive growth as making sure everyone is included in the growth process regardless of their economic class, gender, sex, disability and religion. It is about raising the pace of growth and enlarging the size of the economy by providing a level playing field for investment and increasing productive employment opportunities. In lieu of this, inclusiveness is all about giving equal access to all, irrespective of their status, then been marginalized. The emphasis here is on access to markets, resources, and unbiased regulatory environment for businesses and individuals, commission on growth and development. Also, systematic inequality of opportunity was considered "toxic" as it will derail the growth process through political channels or conflict. Participation of reproductive women in entrepreneurship does not only help them overcome market failure but assist them in time constraints associated with motherhood by reducing their skills deterioration [18].

Food security has been defined by several bodies. Prominent amongst them are: Food and Agricultural Organization, [19] which defined food security as having both physical and economic access to the basic things of life such as sufficient, safe and nutritious food to meet human dietary needs for utmost life performance at all times. Also, [20] defined food security in like manner, emphasizing same point, by stressing the needs of access to sufficient, safe, and nutritious food that meet the dietary needs of human for active and healthy life, for all people and at all times. This definition encompasses the totality of man and his warfare. Considering the goals of SDG 2 of zero hunger by 2030, which had led to the improvement of reducing the undernourished from 14.7% to 10.8% respectively in 2000 and 2015.

According to [21], there was a decline of the undernourished from 28.5 per cent in 1999–2001 and 22.2 per cent in 2015–2017. Also, an increment from 181.8million to 220.7million. This means, out of 815million of the people in the world, 25% of them are undernourished. This again brings to the fore the importance of food security, as there cannot be the undernourishment without food insecurity. While agriculture is directly linked to food security in Sub-Saharan Africa, women are major players in agriculture. Also, it has been emphasized the fact that malnutrition among adolescents, pregnant and lactating mothers can set up a vicious cycle of deprivation which increase the likelihood of low birth weight,

neo-natal and infant mortality, low immunity, prevalence of diseases and high morbidity risks, poor school attendance and classroom performance, low earning capacity, low productivity, poverty, food insecurity among children and adults of next generation. Due to the afore mentioned, channelling policies that could help enhance their entrepreneurial skills as it relates to their food security is key to raising their social status and overall food security. This is because, if women are given the opportunity to have access to productive resource as their male counterpart, they stand the chance of increasing yield by 20 to 30 per cent which could raise agricultural output in developing countries by 2.5 to 4 per cent., the resultant effects are reduction of hunger by 12 to 17 per cent [22].

Theoretically, the capability approach propounded by [23] in the 1980's laid the foundation of inclusive growth concept. Here emphasis on equality in access to opportunities, resources and freedom to achieve one's goal is important for any economy. Therefore, inclusive growth theory links the key variables in this study because it emphasizes that growth that will be of benefit to all in the society especially the marginalized and disadvantaged must ensure that individuals irrespective of their gender, status in the society or location have access to resources that will help enhance their well-being. In terms of energy access, inclusive growth brings about reduction in inequality in access to resources, implying that if women especially those in the rural area have access to clean energy, productivity will increase in activities such as agriculture, food processing and entrepreneurial ventures, which transits to a more food secure economy.

Though there is no denying the fact that some empirical studies have been carried out on the linkage of gender inequality and food security in Sub-Saharan Africa such as [24] who examined food security, gender inequality and women health [25]. Examined gender inequality as it relates to education in Sub-Saharan Africa, [26] investigated gender inequality as it relates to expenditure and maternal mortality, [27] with the focused on the significant role gender in equality plays, as it pertains to food security in Sub-Saharan African countries [28]. Assessing the level and determinants of food security among young farmers in Africa, [29, 30] investigated food security in India based on the four dimensions of food security as well as the estimated differential in wage income between men and women in farm and non-farm activities [31]. Analysed the various components of food security using the indicator approach and found a wide gap in food security across districts in India. Although, some districts were more food secure as a result of increased food accessibility. In a further study, [32] developed new quantitative indicators assessing agricultural sustainability which involves environmental sustainability, social security, and economic security using the Pressure-State-Response (PSR) model and indicator approach. Furthermore, [33] examined the vulnerability of farmers to climate change perception in Bundelkhand and Central region using a multistage random sampling technique. Findings revealed that farmers are highly vulnerable to climate change thus affecting food security. Incorporating risk and Covid-19, [34] found that Bundelkhand districts were highly food insecure compared to other regions. These studies notwithstanding, to the best of the knowledge of the authors, there is still dearth of studies on the linkage between energy access, entrepreneurship food security in SSA. The objectives of the study are as follows: to examine the impact of energy access on food security in Sub-Saharan Africa; to investigate the impact of entrepreneurship on food security in Sub-Saharan Africa and to examine the gender-differential impact of energy access, entrepreneurship, and energy access on food security in Sub-Saharan Africa.

2 Materials and method

2.1 Data and variables

In this study, the dependent variable, food security, which was proxied by per capita food variability was obtained from the FAO database. This proxy used to represent food security is in line with the study of [35], while other variables follow the study of [2] and [36]. In order to examine the effect of entrepreneurship, the start-up business procedure and the time required to start a business was used because the ease or complexity of registering a business directly impacts the level of entrepreneurial activity in a country. This is because a simplified registration process encourages more people to become entrepreneurs, reduces barriers to entry, and facilitates the formalization of businesses. Likewise, employment in agriculture has been used by other studies because it a significant source of employment and income, which helps improve food security. Likewise, including female, male and total population is to provide a comprehensive understanding of the countries demographic structure, analyse gender disparities and women's participation in achieving food security in SSA. The various indicators for entrepreneurship as well as Agricultural employment and GDP were sourced from the WDI database. To actualize the study's objectives, panel data analysis on 45 Sub-Saharan Africa countries for the periods, 2001–2022 was carried out. All the variables were summarized in Table 1

2.2 Specification of the model

The study used the random effect as a baseline model. The variance is usually regarded as spontaneous with the explanatory variables within entities in random effects. Instead of measuring the variance between levels, this estimator draws inferences on value distribution. This estimator is also known as a variance factor model. The estimator should be considered and used when differences between individuals affect the explained variable. The estimator is also more advantageous over the fixed effect model and the POLS as it allows the time-invariant variable to be summed up.

$$Y_{ij} = \mu + U_i + W_{ij} \tag{1}$$

where μ = Average independent variables among the countries., U_i = Country specific random effect, W_{ij} = Individual specific random effect. However, this research paper adopts the GMM as the main estimator for discussion as it controls for endogeneity unlike the fixed effect and POLS. A merit accrued to this technique is the method's effectiveness when adopting instruments while estimating in panel data analysis. The estimator model is expressed in Eq. (2)

$$IPC_{it} = \beta_0 + \beta_1 lnPC'_{it-1} + \beta_2 ISB'_{it} + \beta_3 ITB'_{it} + \beta_4 IAE_{it} + \beta_5 IGDP'_{it} + \beta_6 IPOP'_{it} + \beta_7 IENA_{it} + \mu_{it} \tag{2}$$

where IPC_{it} represents the natural logarithm of per capita food production, IPC_{it-1} represents the first lag of logarithm of per capita food production. Also, ISB_{it}, ITB'_{it} and $IAE_{it} IGDP'_{it}$ and $IPOP'_{it}$ represent the natural logarithm of business start-up procedures, time required to start a business, agricultural employment, gross domestic product and population of ages between 15 and 64 (total, men and women), respectively. β_0 is the intercept term, β_1 is the coefficient of the lagged dependent variable (per capita food variability), β_2, β_3, β_4, β_5, *and* β_6 are the coefficients of the explanatory variables, the disturbance term is represented by μ, *i* represents the country id spanning from 1 to 45 while *t* represents the period spanning from 1 to 21.

2.3 Data and estimation technique

This paper empirically explores a gender-based analysis on interrelationship between entrepreneurship, energy access, and food security in SSA. The countries are Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cabo Verde, Central African Republic, Chad, Comoros, Congo, Rep., Congo, Dem. Rep., Cote d'Ivoire, Eritrea, Equatorial Guinea, Ethiopia, Gabon, Gambia, The, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Tanzania, Togo, Uganda, Zambia and Zimbabwe. For this purpose, all the data used in the study comes from the World Bank's World Development Indicators (WDI) over the period from 2001 to 2022. The study uses the Random effect estimator as the base estimator and the Generalized Method of Moments (GMM) as the main estimation technique, to test for endogeneity during the estimation process.

Table 1 Variables, measurements, sources and expectations. Source: Authors' Compilation

Variable	Code	Measurement	Source	Expectations
Food security	PC	Per capita food variability	FAO	Not Applicable
Start-up business procedures	SB	Start-up procedures to register a business (number)	WDI	Negative (–)
Time required to start a business	TB	Time required to start a business (days)	WDI	Negative (–)
Agricultural employment	AGRIMP	Employment in agriculture (% of employment) (modeled ILO estimate)	WDI	Positive (+)
Energy access	ENA	Access to electricity (% of population)	WDI	Positive
Gross domestic product	GDP	GDP (current US$)	WDI	Positive (+)
Female population	POPF	Population ages 15–64, female	WDI	Negative (–)
Male population	POPM	Population ages 15–64, male	WDI	Negative (–)
Total population	POPT	Population ages 15–64, total	WDI	Negative (–)

NB WDI and FAO mean World Development Indicators and Food and Agricultural Organisation respectively

3 Results

3.1 Description of variables

The Table 2 (panel A) gives the results of the descriptive statistics for all variables used in this paper. Results indicate that the mean per capita food variability (PC) in SSA for the time period considered is 10.33667. Therefore, averagely, per capita food variability in SSA is moderately high. Moreover, the mean start-up procedures required to start a business in SSA is approximately 9.5 procedures. Also, the mean time required to start a business in the region is about 44.6 days. The mean employment in agriculture in the subregion is over 53%. The average gross domestic product for the subregion was 2.91e + 10. Mean total population of individuals between the ages of 15–64 in SSA was 1.04e + 07 with average number of males and females between the age group being 5120111 and 5243516 respectively.

3.2 Random effect estimation technique results

Table 2 (panel B) presents the results of the random effects, which is performed as a baseline estimator for the independent variables. The estimator was used instead of the Fixed effects model due to the results from the Hausman test. Estimates showed that the number of start-up procedures required to start a business has a negative and statistically significant relationship on per capita food variability when analysis is made with the total population of individuals between the ages of 15–64. This negative relationship also exists when analysis is done with both genders, male and female. However, the estimates with female population were slightly higher than that with male population. Estimates showed that a percentage increase in the number of start-up procedures will lead to a 0.3856% and 0.3851% decrease in per capita food variability, when analysing with female and male population respectively.

Table 2 Summary statistics and random effects results. Source: Authors (*, **, *** means significant at 1%, 5% and 10%, respectively

	Summary statistics		Fixed effects results		
	Panel A		Panel B		
Variables	Mean (SD)	Min (Max)	Female	Male	Total
PC	10.33667	0.6			
	(7.819839)	(41.3)			
SB	9.577936	3	− 0.3856114***	− 0.3851498***	− 0.3853856***
	(3.170953)	(18)	(0.002)	(0.002)	(0.002)
TB	44.64817	2.5	0.0046363	0.0046387	0.004637
	(42.81229)	(261)	(0.556)	(0.555)	(0.556)
AE	53.31011	3.116017	0.0834947***	0.083338***	0.0834163***
	(23.38659)	(96.45117)	(0.004)	(0.004)	(0.004)
GDP	2.91e + 10	7.60e + 07	3.00e-11***	3.00e-11***	3.00e-11***
	(7.43e + 10)	(5.74e + 11)	(0.001)	(0.001)	(0.001)
POPF	5243516	25735	− 1.33e-07*		
	(8014239)	(5.67e + 07)	(0.071)		
POPM	5120111	27428		− 1.32e-07*	
	(8007653)	(5.79e + 07)		(0.075)	
POPT	1.04e + 07	53163			− 6.62e-08*
	(1.60e + 07)	(1.15e + 08)			(0.073)
Constant			9.507084***	9.486226***	9.497065***
			(0.000)	(0.000)	(0.000)
F-stat			18.46***	18.44***	18.45***
			(0.0000)	(0.0000)	(0.0000)
Hausman			1.51	1.60	1.55
			(0.6794)	(0.6605)	(0.6701)

The estimates from the random effect showed that the required time to start a business has a positive and statistically significant relationship on per capita food variability when analysis is made with the total population of individuals between the ages of 15–64. This positive relationship also exists when analysis is done with both genders, male and female. However, the estimates with female population were slightly lower than that with male population. The estimates showed that a percentage increase in the number of start-up procedures will lead to a 0.004363% and 0.004368% increase in per capita food variability, when analysing with female and male population respectively.

Estimates also showed that agricultural employment has a positive and statistically significant relationship on per capita food variability when analysis is made with the total population of individuals between the ages of 15–64. This positive relationship also exists when analysis is done with both genders, male and female. However, the estimates with female population were slightly higher than that with male population. Estimates showed that a percentage increase in agricultural employment will lead to a 0.08349% and 0.08333% increase in per capita food variability, when analysing with female and male population respectively.

The estimates from the estimator also showed that the GDP has a positive and statistically significant relationship on per capita food variability when analysis is made with the total population of individuals between the ages of 15–64. This positive relationship also exists when analysis is done with both genders, male and female. However, the estimates showed similar coefficients between analysis with both genders. The estimates showed that a percentage increase in GDP will lead to a 3.00e-11% increase in per capita food variability, when analysing with both genders. Also, estimates showed that an increase in the population of individuals of the age 15–64 has negative effects on food security. This negative relationship is also seen in the male and female population of the total population when analysed individually. However, the estimates showed that a percentage increase in female population (1.33e-07%) cause a higher reduction in food security than a percentage increase in men population (– 1.32e-07%) between the specified ages.

3.3 GMM estimation results

The results from Table 3 revealed that the number of start-up procedures required to start a business has a negative and statistically significant relationship on per capita food variability when analysis is made with the total population of individuals between the ages of 15–64. This negative relationship also exists when analysis is done with both genders, male and female. However, the estimates with female population were slightly lower than that with male population. Estimates showed that a percentage increase in the number of start-up procedures will lead to a 0.99% and 1.01% decrease in per capita food variability in Sub-Saharan Africa, when analysing with female and male population respectively.

Table 3 revealed that the time required to start a business has a positive and statistically significant relationship on per capita food variability, when analysis is made with the total population of individuals between the ages of 15–64. This positive relationship also exists when analysis is done with both genders, male and female. However, the estimates with female population were slightly lower than that with male population. Estimates showed that a percentage increase in the time required to start a business will lead to a 0.017% and 0.018% increase in per capita food variability in Sub-Saharan Africa, when analysing with female and male population respectively.

The results from Table 3 revealed that agricultural employment has a positive and statistically significant relationship on per capita food variability when analysis is made with the total population of individuals between the ages of 15–64. This positive relationship also exists when analysis is done with both genders, male and female. Table 3 revealed that GDP has a positive and statistically significant relationship on per capita food variability when analysis is made with the total population of individuals between the ages of 15–64. This positive relationship also exists when analysis is done with both genders, male and female. However, the estimates with female and male population were similar. Estimates showed that a percentage increase in the number of start-up procedures will lead to a 2.89e-11% increase in per capita food variability in Sub-Saharan Africa, when analysing both female and male population. This estimate indicates an inelastic relationship between the variables in the short run, ceteris paribus.

The results from Table 3 revealed that an increase in the population of individuals of the age 15–64 has negative effects on per capita variability. This negative relationship is also seen in the male and female population of the total population when analysed individually. However, the estimates showed that a percentage increase in female population (– 1.60e-07%) cause a lower reduction than a percentage increase in men population (– 1.63e-07%) between the specified ages in per capita food variability in Sub-Saharan Africa, respectively.

Table 3 GMM results. Source: Authors (*, **, *** means significant at 1%, 5% and 10%, respectively

Variables	Female	Male	Total
SB	− 0.9988829***	− 1.019052***	− 1.01055***
	(0.000)	(0.000)	(0.000)
TB	0.0170077***	0.0181149***	0.0176245***
	(0.003)	(0.001)	(0.002)
AGRIMP	0.1790308***	0.1820461***	0.1810255***
	(0.000)	(0.000)	(0.000)
GDP	2.89e-11***	2.92e-11***	2.92e-11***
	(0.000)	(0.000)	(0.000)
ENA	0.31011**	0.11601***	0.08391***
	(0.038)	(0.000)	(0.001)
POPF	− 1.60e-07***		
	(0.000)		
POPM		− 1.63e-07***	
		(0.000)	
POPT			− 8.13e-08***
			(0.000)
Constant	9.785598***	9.754441***	9.757734***
	(0.000)	(0.000)	(0.000)
AR (1)	3.00***	4.99***	5.83***
	(0.003)	(0.003)	(0.002)
AR (2)	− 3.15	− 5.16	6.24
	(0.200)	(0.603)	(0.302)

4 Discussion

Energy Access and Food Security The findings suggest that access to reliable and affordable energy sources is crucial for improving food security in Sub-Saharan Africa. Energy access enables individuals to store, process, and preserve food supply chain effectively, thereby reducing post-harvest losses and ensuring a stable food supply, similar to the findings of [37–39]. Moreover, access to energy facilitates agricultural activities [3, 40], such as irrigation, mechanization, and agro-processing, which can enhance productivity and increase food production. Lack of energy access, on the other hand, can lead to food insecurity due to limited access to modern cooking facilities, refrigeration, and agricultural technologies. Also, having access to reliable energy improves the use of modern equipment in the agricultural sector, for instance; irrigation system and mechanized tools used in farming. This is expected to lead to a growth spurt in crop yields especially in areas that are prone to unpredictable rainfall pattern or drought, thereby food availability would improve and less dependence on rainfall for agriculture. Furthermore, due to improved access to energy, post-harvest storage also need energy for food processing and this will reduce food spoilage and loss, preserve food and extend shelf life, thereby affecting food security positively.

Entrepreneurship and Food Security The study highlights the positive impact of entrepreneurship on food security outcomes in Sub-Saharan Africa, following [3]. Engaging in entrepreneurial activities, such as small-scale farming, food processing, and market trading, can generate income, create employment opportunities, and improve access to nutritious food. This is because smallholder farmers will be able to generate additional income both from local production and export and when this income is reinvested, they can have access to better seeds and fertilizers which boosts output and allows for meeting basic food needs of the family and the economy. Likewise, due to small scale farming requiring labour for planting and maintain the farmland, employment opportunities can be generated, especially in rural areas where we have limited formal jobs available. Entrepreneurship also fosters innovation, diversification of food sources, and resilience to external shocks, contributing to enhanced food security at the household and community levels [5, 41–43]. This occurs because of the availability of locally produced foods, which are nutrient rich. Also, the production of food locally reduces reliance on imported foods, thus reducing prices and making

it affordable for low-income families. However, challenges such as limited access to finance, market barriers, and gender disparities in entrepreneurship can hinder the potential benefits of entrepreneurial ventures on food security.

Gender Dynamics The study underscores the importance of considering gender dynamics in the context of energy access, entrepreneurship, and food security in Sub-Saharan Africa. Women often face unique challenges related to access to energy resources, participation in entrepreneurial activities, and securing adequate food for their families. Gender inequalities in land ownership [3, 4], access to financial services, and decision-making power can limit women's ability to benefit from energy access and entrepreneurship opportunities, leading to higher levels of food insecurity among female-headed households. Addressing these gender disparities is essential for promoting inclusive and sustainable development that benefits all individuals in the region. Also, when women have support, such as financial independence, increased decision-making power, policies that helps their social standing in the society, it plays a central role in small scale farming and food processing in many SSA countries and this helps with food security.

Population and food security The study revealed that an adverse effect exists between the population of male, female and total population and food security in SSA. The reason for this negative impact could be as a result of high dependence ratio, as SSA has a very young population (under 15) and an increasing elderly population (over 65) which could lead to a high dependence ratio, thus putting a strain on the food security. Also, due to this dependence ratio, government may allocate resources and direct attention to these groups and funds will be diverted from agricultural development, which may affect food security in the region. Also, when there is a high dependence ratio, there will be pressures due to shortage of labour especially in the agricultural sector, as well as an ageing population, will lead to reduced productivity, hence food insecurity. Similarly, women and children are more vulnerable to climate change shocks, such as droughts, floods and extreme weather events and this could disrupt food production and a decline in farm yields and scarcity will persist. Another reason which could account for the negative effect of population is migration to the urban centers, thus reducing the workforce for agricultural activities which can lead to reduced food production, more reliance on food imports and food insecurity worsens. Therefore, an increased dependency ratio of under 15 and over 65 in SSA can affect food security by reducing the workforce available for agricultural production, increasing vulnerability to malnutrition, and stressing economic resources.

5 Conclusion

This study examined the impact of energy access, entrepreneurship and gender-differential on food security in Sub-Saharan Africa. This study focused on food security because it plays a vital and key role in the achievement of growth and sustainable development and included entrepreneurship as well as the contribution of both male and female in order to further enrich the study. The random effect model was used as the baseline estimator and the GMM as the main estimator for discussions and recommendations, because the random effect coefficients could not account for endogeneity system Generalized Method of Moments (SGMM) was utilized and the data was sourced from FAO and WDI for the period 2001 to 2022. and findings reveals that the start up business procedures exerts an adverse effect on food security in SSA, while time to register a business positively affects food security in SSA. Employment in agricultural sector, gross domestic product and energy access all have positive impact on food security in SSA across gender-differentials (female, male and total population). However, female population, male population and total population all have negative impact on food security in SSA. Thus, suggesting that women entrepreneurs face unique challenges in accessing resources and markets, which can impact their ability to contribute to food security. Additionally, the study highlights the importance of gender-sensitive policies and programs that support women entrepreneurs in the food sector. The theory of change from our findings indicates that increasing women's participation in agricultural production and decision making will improve food security. This can be achieved with empowering women, enhancing the economic contributions of women in the agricultural sector and reducing gender disparity, thus leading to food security outcomes. Likewise, access to energy enables more efficient agricultural practices, facilitates improved food storage which reduces post-harvest losses and increase food shelf life. Therefore, for countries in SSA policies should be put in place to reduce the bureaucratic barriers in start-up procedures and reduce the barriers to entrepreneurship, improvement in agricultural sector employment, expansion in energy access especially those in the rural areas involved in farming activities and promoting gender equality in SSA.

Finally, estimates from this research paper suggests that countries in SSA should improve entrepreneurial and agricultural practices that will help to boost food security in the region. The research paper will also aid countries in SSA in achieving Sustainable Development Goals 1, 2, 5, 8, 10, 12, 13 and 17.

Author contributions The study was conceptualized, and its methodology was designed under Romanus Osabohien, Oluwayemisi Kadijat Adeleke contributed through data collection, statistical analysis, and manuscript preparation. At the same time, Elizabeth Udenyi Osabohien worked on the literature review and wrote the introduction and conclusion. Andaratu Achuliwor Khalid analyzed gender dynamics in food security, and Abebe Derbie Aragaw handled correspondence, findings integration, and final editing. Moses Onyesom provided economic impact analysis, and Deborah Agene collected data. Oseghale Ihayere and Moses Onyesom reviewed entrepreneurship, while Mamdouh Al-Faryan advised on regional economic implications. Ifere Eugene Okoi analyzed energy access, and Endurance Igharo integrated gender-focused results.

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Data availability Data will be made available upon request.

Declarations

Ethics approval and consent to participate Not applicable, as this study does not involve human participants or animals subjects.

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