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DOES DOMESTIC FOOD PRODUCTION CONTRIBUTE TO IMPROVED LIFE EXPECTANCY? EVIDENCE FROM LOW-INCOME FOOD-DEFICIT COUNTRIES (LIFDCS) IN AFRICA

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Abstract

This paper examined the role food production could play in enhancing longevity in Africa's low income and food poverty countries. The paper used two cointegrating panel models, namely: dynamic ordinary least squares (DOLS) and fully modified ordinary least squares (FMOLS) in addition to panel OLS and the sample covers the period from 2000-2020. Findings of the study reveal that in all the three panel models used, food production index impacted positively and significantly on life expectancy in the selected countries. Also, while GDP per capita did not positively influence life expectancy; government expenditure on health improved it. The positive impact of nutritional food on life expectancy is thus established. The study is therefore of the view that the government in these countries should enunciate appropriate policies to enhance food security while stepping-up health intervention measures. In addition, there is need for institutional upgrade to ensure that wealth is distributed evenly in these countries.

Keywords: *Food production, Government intervention, GDP per capita, food security*
JEL Codes: *C23, H51, Q18.*

1. Introduction

Among the concerns of policy makers in any country is to enunciate policies that will enhance the living standard of the citizens. Due to the importance attached to living standard, different indicators have been adopted over the years to measure it. A country that has a high living standard enjoys an improved life expectancy. As observed by Hossain (2013), life expectancy is among the measures of quality of life and economic development as well as a major indicator of the health status of the citizens. As contended by Aigheyisi (2020), life expectancy is a person's lifespan or the average number of years one is expected to live from birth. It is an indicator of the extent to which a person is expected to live. The study further contended that if a person's quality of life is high, the person's life expectancy will equally be high. Compared to developed countries, life expectancy in developing countries is usually low. As observed in the study by Freeman, Gesesew, Bambra, Giugliani, Popay, Sanders, Macinko, Musolino and Baum (2020), life expectancy on the average ranges from 52 years in Central African Republic and Sierra Leone, but in Hong Kong and Japan, the range is 84 years. In support of this, report from the 2019 World Development Indicators shows that developed countries enjoy higher life expectancy than the less developed countries. Various factors have been pointed to be responsible for life expectancy as supported by literature; including income level, health status, nutritional food and educational level. Among these factors, nutritional food has been given pre-eminence, perhaps owing to the fact that it directly impacts on people's health. Increasing the output of food, particularly nutritional food therefore has the tendency to prolong life.

This study focuses on low income countries in Africa that suffer from food poverty. As observed by the Food and Agricultural Organization (FAO) 1996, food poverty is a term associated with a condition where individuals do not have adequate, secure and nutritious food that should enhance healthy and active life. The interest of this paper is to examine the impact of food production index on life expectancy in the selected countries. Food production index comprises of all food crops that are regarded as edible and which contain nutrients. Considering that these countries are financially poor, the panacea for improving their life expectancy is to produce and consume nutritious food which may not cost so much as these foods can be cultivated locally. The paper argues that even though the countries suffer food deficit, such could be in terms of quantity but in terms of nutritional quality, they may be better off. The basic question this paper tries to address is if life can be prolonged in these countries as a result of the production and consumption of nutritional foods. In addition, the study sought answers to the impact of other determinants of life expectancy in these countries such as health expenditure and income level. Findings of the study will assist in the formulation of appropriate policies on food security and living standard in the countries sampled and other developing countries that suffer food shortage.

1.1 A brief Profile of the Agricultural Products in the Countries Sampled

In this study, 10 low-income food-deficit countries in Africa were examined, namely: Benin, Burkina Faso, Burundi, Malawi, Cote D'Ivoire, Mauritania, Ethiopia, Gambia, Ghana and Kenya. The economy of the Republic of Benin is mainly agrarian with agriculture supporting a large number of the population. Agricultural production in the country is largely based on subsistence, though with some locally produced commodities exported to nearby neighbouring African countries. Cotton remains its major export crop which accounts for a large share of its export earnings. The crops grown in the country are: pineapples, shea butter, cashews, shea nuts, palm products, beans, corn, vegetables, fruits, *etc.* In Burkina Faso, the three major coarse cereal crops produced and consumed are millet, maize and sorghum. There is self-sufficiency in the production of mainly millet and sorghum just as maize production has been on increase. An important staple food for the country is rice, though its local production is not adequate for domestic consumption, thus giving room for augmentation through importation. Other crops produced in smaller quantity are shea nut, peanut, soybean oil and so on. A major limiting factor in crop production in the country is lack of adequate irrigation which leaves production to depend largely on rainfed. So, in periods of prolong drought, crop production suffers. The landlocked nature of Burundi is among the factors that reduce it to a resource-poor country coupled with the fact that the country has weak manufacturing and service sectors. A large population of the country lives in the rural areas, thus making agriculture the mainstay of the economy. In Burundi, the production of vegetables and fruits are done in market gardens which produce mainly for use by household. In Malawi, the economic products are: cotton, tea, tobacco, groundnuts, coffee and sugar. A major export earner for the country is tobacco which accounts for a large percentage of the country's export earnings. In addition to this, other major crops grown in the country are: sugar, nuts, legumes, sorghum, sweet potatoes, rice, cassava, maize and a host of other crops. The country also raises goats, sheep and cattle. Industries operating in the country are mainly agricultural processing industries that process sugar, tea and tobacco.

The mainstay of the economy of Cote D'Ivoire is agriculture that is supported by a high percentage of agricultural land. Revenues from the export of coffee and cocoa contribute much to the total export revenue of the country. Other crops which are exported unprocessed include: rubber, palm oil, bananas, cashew nuts, coffee, cocoa and other crops, all which are produced by both large and small-scale farmers. The country imports rice in large quantity and other crops imported are: cornmeal, wheat and dairy products. Agricultural production in Mauritania

is very poor compared to other West Africa countries. Livestock production is a major preoccupation of the rural dwellers in the country. Among the main crops grown in the country include: sorghum, corn, rice, millet as well as other root crops. Low water supply is a major constraint for farming in the country. In Ethiopia, agricultural production contributes to a large proportion of the country's gross domestic product (GDP) and also contributes much to the employment level in the country. Among the major crops grown in the country are: beans, potatoes, vegetables, oilseeds, coffee, and cereals. The largest foreign exchange earner is coffee which contributes a high percentage of foreign exchange. Consistent drought and the degradation of the soil through deforestation and overgrazing adversely affect agricultural productivity in the country. Gambia's economy is sustained by the activities in the agricultural sector as the country lacks commercial mineral resources and a developed manufacturing sector. Among the main crops grown in the country are: millet, rice, sorghum, peanuts, cashews and mangoes. A variety of agricultural commodities are produced in Ghana and agriculture contributes a large share of employment in the economy of the country. The major crops grown in the country include: oil palm, yam, sorghum, cocoyam, plantain, cassava, cocoa, maize and do on. Prolong drought affects agricultural productivity in Ghana since all agricultural production is based on rainfed. In Kenya, agricultural productivity contributes a large share of the country's GDP. Most of the crops grown in the country are mainly for subsistence basis. Among the major crops grown in the country are: rice, wheat, beans, maize, potatoes and Irish potato.

1.2 Evolution of Food Production Index and Life Expectancy in the Selected Countries

In Figure 1, food production index for the entire selected countries exhibited rising trend in most of the years sampled. Gambia's food production index experienced fluctuations in some of the years even though it trended higher than other countries, except in 2013 when Burundi's trend was highest compared to other countries. The three countries with the highest food production index within the study period are Gambia, Burundi and Mauritania. However, the countries with the lowest food production index are Mali, Ethiopia and Ghana. With respect to life expectancy, evidence in Fig. 2 reveals that Mauritania had the highest life expectancy up till 2013 when Kenya's trend marginally rose higher than the rest of the countries sampled. From 2000 through 2006, Mali had the lowest life expectancy, however; the trend for Cote D'Ivoire was the lowest starting from 2007. A major feature of the countries sampled is that life expectancy never attained 70 years. Life expectancy for Gambia which had the highest food production index was not the highest or even the second highest within the period. However, around 2006 when Mali had very low food production index, its life expectancy was equally low.

Tables 1 and 2 present information on both female and male life expectancy for the countries sampled. Evidence in Table 1 revealed that female life expectancy was highest in Mauritania up rill 2012, but in 2013 Ethiopia had the highest life expectancy. Beginning from 2014, Kenya's life expectancy rose higher than that of other countries in the sample. Burkina Faso and Cote D'Ivoire had the lowest female life expectancy compared to other countries within the sample period. Information on Table 2 reveals that Mauritania and Ghana had the highest male life expectancy within the sample period. The country with the lowest male life expectancy among the countries sampled is Côte d'Ivoire. Malawi equally had low life expectancy relatively up till 2016, but from 2017 its male life expectancy improved. In both male and female life expectancy, it is revealed that Mauritania exhibited a high trend compared to other countries.

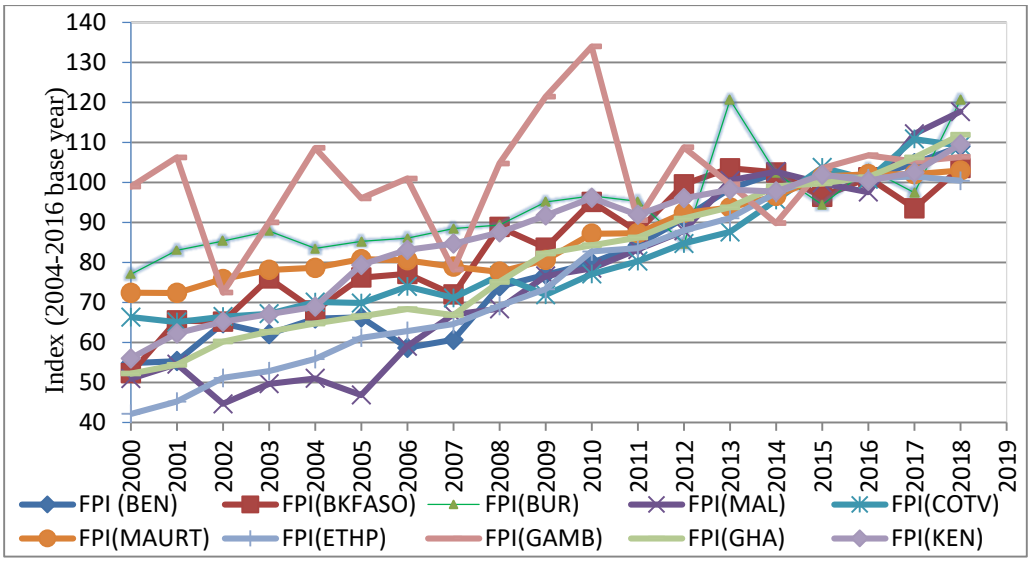

Figure 1. Evolution of Food Production Index for the Sampled Countries

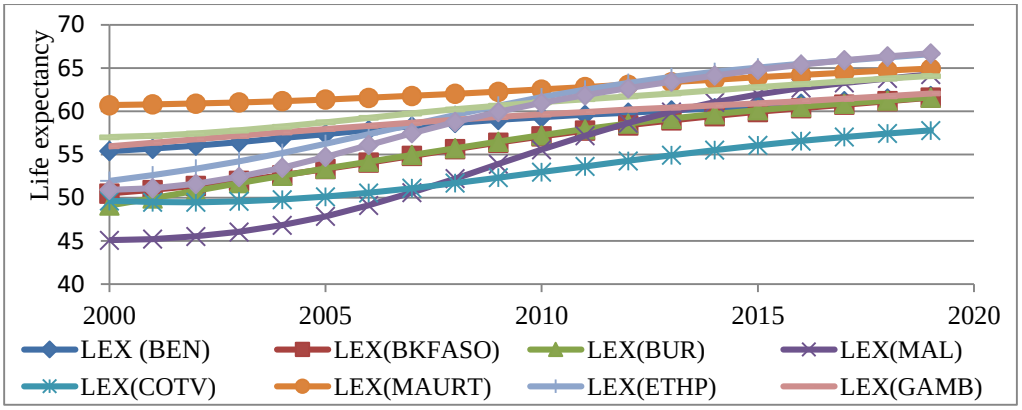

Figure 2. Evolution of Life Expectancy for the Sampled Countries

Table 1. Female Life Expectancy in the Sampled Countries

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Benin	60.7	60.9	61.2	61.5	61.7	62.1	62.3	62.6	63.0	63.3
Burkina Faso	57.6	58.3	58.9	59.4	60.0	60.5	60.9	61.4	61.8	62.2
Burundi	58.9	59.6	60.3	60.9	61.4	61.8	62.3	62.6	63.0	63.3
Malawi	58.3	60.0	61.5	62.9	64.0	65.0	65.7	66.4	66.9	67.4
Côte d'Ivoire	54.4	55.0	55.6	56.2	56.7	57.3	57.8	58.3	58.7	59.1
Mauritania	64.2	64.5	64.8	65.07	65.3	65.5	65.8	66.1	66.2	66.5
Ethiopia	63.3	64.2	65.0	65.7	66.3	66.9	67.3	67.7	68.1	68.5
Gambia	60.9	61.2	61.5	61.7	62.0	62.2	62.5	62.8	63.1	63.4
Ghana	61.9	62.3	62.6	62.9	63.3	63.7	64.1	64.5	64.8	65.1
Kenya	62.9	63.9	64.8	65.6	66.4	67.1	67.7	68.2	68.6	69.0

Table 2. Male Life Expectancy in the Sampled Countries

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Benin	57.8	58.1	58.3	58.6	58.8	59.1	59.3	59.6	59.9	60.2
Burkina Faso	56.4	57.1	57.7	58.2	58.7	59.1	59.5	59.9	60.3	60.7
Burundi	55.4	56.1	56.7	57.3	57.8	58.3	58.7	59.1	59.4	59.7
Malawi	52.8	54.3	55.7	56.9	58.0	58.8	59.5	60.1	60.6	61.1
Côte d'Ivoire	51.6	52.3	53.1	53.7	54.3	54.9	55.4	55.8	56.2	56.5
Mauritania	60.7	60.9	61.2	61.6	61.9	62.2	62.5	62.8	63.1	63.3
Ethiopia	59.9	60.8	61.5	62.1	62.7	63.2	63.6	63.9	64.3	64.6
Gambia	58.3	58.6	58.9	59.1	59.3	59.6	59.8	60.1	60.3	60.6
Ghana	60.1	60.4	60.7	61.1	61.4	61.8	62.1	62.4	62.7	62.9
Kenya	58.9	59.7	60.4	61.1	61.8	62.4	63.0	63.5	63.9	64.3

2. Review of Studies that Examined the Link between Diet and Lifespan

To better capture the essence of food on life expectancy, some studies across regions of the world have been conducted which revealed the link between diet and lifespan. Through dietary consumption, nutrients are supplied to human body. Studies have shown that certain foods or certain compounds in foods can prevent diseases and thus reduce mortality rate. Accordingly, these foods are relatively rich in antioxidants that reduce mortality. Findings have indicated that Mediterranean diets have been associated with good health and improved lifespan. These diets have been found to be rich in seafood, nuts, legumes, fruits and so forth, while also are low in meat and saturated fats. Among the Mediterranean populace, intake of alcoholic beverages and wine has also found to be popular. In a study involving the Greek adults, findings by Trichopoulou, Costacou, Bamia and Trichopoulos (2003) revealed that the ingestion of Mediterranean diet was correlated with low mortality. In another vein, the Nordic diets which contain whole grain bread, oatmeal, yogurt, root vegetable, fish/shellfish, cabbage *etc*; have been found to improve lifespan. In a study involving the Danes, Olsen, Egeberg, Halkjær, Christensen, Overvad and Tjønneland (2011) showed that low mortality was linked with the consumption of Nordic diet, more so among middle-aged men. Supporting this finding, Roswall, Sandin, Lof, Skeie, Olsen, Adami and Weiderpass (2015), in a study involving the Swedish women, revealed that mortality lowered significantly with the consumption of Nordic diet. In a study for Japan, Abe, Zhang, Tomata, Tsuduki, Sugawara and Tsuji (2020) found that Japanese diet which comprise mostly of seaweed, rice, cucumber, green and yellow vegetables, green tea, fish, coffee and others, improved longevity. The outcome of this study finds support in Okada, Nakamura, Ukawa, Wakai, Date, Iso and Tamakoshi (2018) which revealed that the consumption of Japanese diet reduces mortality, mostly among women.

2.1 Review of other Factors that Influence Life Expectancy

A host of factors have been identified in literature to affect life expectancy across different countries. In this empirical literature review, the study attempts to present these factors. In a study for Nigeria, Uyoyou (2010) examined the constraints to food security and the effects on Nigerians. The study revealed that low income and poverty are among the factors that constrain food security in Nigeria, while malnutrition, high mortality rate and low lifespan are the consequences of food insecurity. In China, Gibson, Zhu, Ge and Wahlqvist (2015) found that population features and livelihoods linked to food systems are responsible for much of life

expectancy as a health outcome. In a study for Pakistan, Shahbaz, Loganathan, Mujahid, Ali and Nawaz (2015) used the auto regressive distributed lag (ARDL) bounds model to reveal that food supply leads to life expectancy. The study equally found that while illiteracy and rise in economic misery reduced life expectancy, urbanization enhanced it. A study by Somayeh, Hamed, Satar, Mehdi, Sajad, Ali and Razieh (2016) for Iran indicated that GDP per capita and food availability had a positive and significant impact on life expectancy at birth. In another cross-country study involving developing countries, Hassan, Minato, Ishida and Nor (2017) used the fixed effect model to show that both education and GDP improved life expectancy. Using dynamic ordinary least squares (DOLS) method in a study for the United States, Ketenci and Murthy (2018) found that both educational attainment and real per capita income impacted positively on life expectancy.

In Kenya, Njiru and Letema (2018) used descriptive statistics to reveal that energy poverty had a negative impact on life expectancy, literacy levels, calorific intake and health. Another study for Iran by Golkhandan (2019) showed that while food production index, per capita public health expenditure and urbanization raised life expectancy, misery index and illiteracy rate reduced it. The positive impact of GDP per capita and food production index on life expectancy found support in the finding by Somayeh *et al*. (2016). In a study involving 17 regions of Spain, Cervantes, López and Rambaud (2019) used the Granger (none) causality test to prove that per capita income and number of medical staff Granger-caused life expectancy. Etikan, Babatope, Yuvah and Ilgi (2019) investigated the determinants of life expectancy in Nigeria. The study found evidence of a negative effect of private expenditure on health on life expectancy, while the effect of improved access to safe water and basic sanitation system was positive. Furthermore, the study found government expenditure on health to impact positively on life expectancy even though the result was not significant. For Turkey, Gulcan (2020) used the vector error correction model (VECM) to reveal that while GDP per capita and urbanization negatively impacted on life expectancy at birth, food production index and CO2 emission had positive impact on life expectancy at birth. In Nigeria, Aigheyisi (2020**)** used the ARDL to show that improvement in agricultural productivity improved life expectancy only in the short run. Also, while health expenditure was found to positively impact on life expectancy in both the short and long run, the impact of unemployment, inflation and real per capita income was negative. In another study for Nigeria, Agu, Agu and Onwuteaka (2020) revealed that food poverty had a negative impact on life expectancy, but the impact of food importation, capital formation and total labour force was positive. In a panel study involving Albania, Bosnia, Macedonia, Montenegro and Serbia, Miladinov (2020) used the full information maximum likelihood (FIML) estimator to show that while the impact of GDP per capita on life expectancy was positive, the impact of infant mortality rate was negative.

3. Methodology

In the estimation of a panel framework with co-integration, various methods are adopted including the ordinary least squares (OLS), dynamic ordinary least squares (DOLS), fully modified ordinary least squares (FMOLS), pooled mean group (PMG); among others. As observed by Chen, Clarke and Roy (2014), in the analysis of the sample proprieties of the OLS estimator such as the bias-corrected t-statistic, the t-statistic and the bias-corrected OLS estimator, the bias-corrected OLS estimator hardly improved over the OLS estimator. Consequently, other co-integrated panel regressions have been suggested to be more appropriate such as DOLS estimator and FMOLS estimator. Even though the FMOLS is thought to remove serial correlation in the errors as well as handle the presence of endogeneity in the regressors, Kao and Chiang (2000) have revealed that it exhibits bias in small sample, observing that the DOLS estimator performs better. This study therefore employs the panel

OLS, panel DOLS and panel FMOLS in the analysis of the contribution of domestic food production to life expectancy in Africa's low-income food-deficit countries. Two panel unit root tests were used to test the stationarity of the series and they are Levin, Lin and Chu (LLC) and Im, Pesaran and Shin (IPS). The LLC tests for stationarity when the countries are pooled together, while IPS tests for stationarity of the individual countries. In testing for cointegration among the series, the paper used both the Pedroni residual panel cointegration test and the Johansen Fisher panel cointegration test.

3.1 Pedroni Panel Cointegration Test

Pedroni (1999) recommended the estimation of a panel cointegration model with heterogeneous intercept and trend coefficient across country. Modified from Abdullah, Siddiqua and Huque (2017), this study estimated the following regression:

$$LEX_{i,t} = \alpha_i + \omega_{it} + \pi_1 FPI_{i,t} + \pi_2 FIMPT_{i,t} + \pi_3 LGDPPC_{i,t} + \pi_4 GEH_{i,t} + \varepsilon_{o,t} \quad (1)$$

where, $i = 1,2,---,N$ and $t = 1,2,---,T$

LEX = life expectancy, FPI = food production index, $FIMPT$ = food import, $LGDPPC$ = log of gross domestic product per capita and GEH = government expenditure on health. It is assumed here that all the variables are integrated of order one, that is they are *I(1)*. The residuals from equation 1 above is derived by performing an augmented Dickey-Fuller (ADF) test on the residuals so as to ascertain whether they are *I(1)*. The following regression test for each country is used to achieve that:

$$\Delta\varepsilon_{i,t} = \lambda_{it}\varepsilon_{i,t-1} + \sum_{j=1}^{P_i} \delta_{ij}\Delta\varepsilon_{i,t-1} + \eta_{i,t} \quad (2)$$

As noted by Abdullah *et al.* (2017), a total of eleven statistics in two groups was provided by Pedroni. The two groups are: panel statistic (within dimension) and group statistic (between dimension). To investigate the existence of cointegration, the following null hypothesis is tested against the alternative hypotheses:

$H_0 : \lambda_i = 0$ (No cointegration)

Homogeneous Alternative, $H_1 : (\lambda_i = \lambda) \prec 1\nabla i$

Heterogeneous Alternative, $H_1 : \lambda_i \prec 1\nabla l$

While panel statistic is associated with homogeneous alternative, group statistics is associated with heterogeneous alternative.

3.2 Specification of the Cointegrating Relationship

As usual with times series data, we suspect that the data used in this study, namely: food production index, food import, GDP per capita and government expenditure on health may become endogenous just as the error terms may be serially correlated. To take care of these two problems, this study adopted two estimators namely FMOLS and DOLS. The FMOLS estimators resulted from a semi parametric proposition by Phillips and Hansen (1990) which is meant to correct the problem of long run correlation among cointegrating equation as well as the stochastic regressors' innovations. In another vein, the DOLS estimator resulted from the asymptotically efficient estimator as proposed by Saikkonen (1992) and Stock and Watson (1993). This estimator removes the feedback in the cointegrating system by augmenting the

cointegrating regression with lags and leads of the regressors. The FMOLS estimator can be explained using the following fixed effect model:

$$LEX_{i,t} = \alpha_i + \chi_{i,t}^{\iota}\zeta + \mu_{i,t} \quad (3)$$

where, $i = 1,2,---,N$ represent indexes cross section and $t = 1,2,---,T$ are time series units. The dependent variable, Life expectancy is an *I(1)* process), ζ is a vector of parameters, α_i is intercepts and $\mu_{i,t}$ is a stationary error terms. Here $\chi_{i,t}$ are assumed to be $(4x1)$ vector of independent variables (food production index, food import, GDP per capita and government expenditure on health) which are I(1) for all cross section units. $\chi_{i,t}$ is assumed to follow an autoregressive process of the form below:

$$x_{i,t} = x_{i,t-1} + \varepsilon_{i,t} \quad (4)$$

The innovation vector is stated as: $\psi_{i,t} = (\mu_{i,t}, \varepsilon_{i,t})$

It is given that $\psi_{i,t} = (\mu_{i,t}, \varepsilon_{i,t}) \approx I(0)$ and such being the case, cointegration exists among the variables for each members of the panel with cointegrating vector ζ. Through the correction for endogeneity (that is by modifying $LEX_{i,t}$) and the correction for serial correlation (that is modifying long run covariance of innovation vector $\psi_{i,t}$), the FMOLS estimator can be obtained. Consequently, the estimator can be expressed as follows:

$$\hat{\zeta}\, FMOLS = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it} - x_i)(\bar{\chi}_{it} - \bar{\chi}_{it})^{\iota}\right]^{=1} * \left[\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(x_{it} - \bar{\chi}_{it})\hat{LEX}_{it} - T\hat{\Delta}\varepsilon_{it}\right)\right]. \quad (5)$$

Following Saikkonen, (1992), to control for endogeneity, the cointegrating regression is augmented by lead and lagged differences of FPI and other independent variables in the DOLS framework. Also, following Stock and Watson (1993), to control for serial correlation, the lead and lagged differences of the LEX has to be included in the equation. Thus, the equation for the DOLS framework is stated as follows:

$$LEX_{i,t} = \alpha_i + \zeta_i x_{i,t} + \sum_{k=p_1}^{p_2}\vartheta_k \Delta LEX_{i,t-k} + \sum_{k=-q_1}^{q_2}\sigma_k \Delta x_{i,t-k} + \mu_{i,t} \quad (6)$$

3.3 Data and Variables

The study utilized annual series that spanned the period from 2000-2020. The data for all the variables were sourced from the World Bank development Indicators. GDP per capita was measured in constant 2015 US$ for all the countries, while food imports was measured as a percentage of merchandise imports. Life expectancy was measured as total years from birth; government expenditure on health was measured as current health expenditure per capita in current US Dollars. Food production index was measured using 2014-2016 base year.

4. Preliminary Results

With the descriptive statistics, the features of the variables used in the study are analyzed. In Table 3 below, findings reveal that closeness exists between the mean and the median of each of the variables. The implication of this is that the variables are symmetric and their level of dispersion is equally low. It is also revealed the food production index (FPI) has the highest

mean with a mean value of 76.74 and a standard deviation of 29.92. However, the variable with the lowest mean is GDP per capita with a mean value of 2.89 and standard deviation of 0.27. In another vein, the variable with highest range within the study period is FPI which indicates that it exhibited high volatility within the period.

Table 3. Results of Descriptive Statistics

	LEX	FPI	FIMPT	LGDPPC	GEH
Mean	55.3	76.7	18.9	2.89	28.8
Median	58.6	83.5	15.8	2.96	25.2
Maximum	66.6	133.9	54.9	3.36	109.9
Minimum	0.00	0.00	0.00	2.41	0.00
Std. Dev.	13.3	29.9	10.1	0.27	21.5
Skewness	-3.40	-1.31	1.08	-0.28	0.99
Kurtosis	14.4	4.38	3.96	1.74	4.00
Jarque-Bera	1543.6	76.7	48.8	16.3	42.7
Probability	0.00	0.00	0.00	0.00	0.00
Sum	11505.2	15962.6	3941.9	602.5	5990.7
Sum Sq. Dev.	36744.48	185360.7	21187.2	16.1	95991.6
Observations	208	208	208	208	208

The results of stationarity in Table 4 reveal that stationarity was achieved for life expectancy at level under the LLC. However, while stationarity was achieved for food production index at level under LLC, the variable became stationary at first difference under PP-Fisher. Also, while Food import was found to achieve stationarity at level under both the LLC and PP-Fisher, GDP per capita became stationary at first difference under both LLC and PP-Fisher. Government expenditure on health became stationary at level under the LLC, but under PP-Fisher it became stationary at first difference.

Table 4. Results of Stationarity

	LLC		PP-FISHER	
	LEVEL	FIRST DIFF.	LEVEL	FIRST DIFF.
LEX	-4.4(0.0)	-3.0(0.0)	14.4(0.8)	23.6(0.2)
FPI	-2.3(0.0)	-6.0(0.0)	20.6(0.4)	179.6(0.0)
FIMPT	-1.5(0.0)	-13.4(0.0)	46.5(0.0)	193.6(0.0)
LGDPPC	0.7(0.7)	-3.2(0.0)	6.2(0.9)	79.2(0.0)
GEH	-2.5(0.0)	-3.7(0.0)	9.0(0.9)	66.4(0.0)

Table 5. Pedroni Residual Panel Cointegration Test

	t-statistics	Prob.
within group		
Panel v-Statistic	4.09	0.00
Panel rho-Statisti-	-2.03	0.02
Panel PP-Statistic	-6.69	0.00
Panel ADF-Statistic	-0.44	0.03
between group		
Group rho-Statistic	0.06	0.52
Group PP-Statistic	-5.62	0.00
Group ADF-Statistic	-0.60	0.02

In Table 5, the results of Pedroni panel cointegration test reveal that the panel PP-statistics and panel ADF-statistics are statistically significant at the 5% for both within group and between group. This implies that the series are cointegrated or have a long-run relationship. In Table 6, the results of the Johansen Fisher panel cointegration test reveal that the probability values of both the Trace and the Maximum Eigenvalue tests are less than the 5% level. This indicates that the series are cointegrated, thus supporting the results of the Pedroni test.

Table 6. Johansen-Fisher Panel Cointegration Test

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	352.8	0.00	210.0	0.00
At most 1	191.4	0.00	82.0	0.00
At most 2	127.3	0.00	65.8	0.00
At most 3	85.5	0.00	57.9	0.00
At most 4	70.6	0.00	70.6	0.00

4.1 Regression Results

In this study, three panel regression models were used namely: panel fully modified OLS (FMOLS), panel dynamic OLS (DOLS) and panel OLS. The results in Table 7 reveal that while the explanatory power of both panel fully modified OLS and panel OLS are low, that of panel dynamic OLS is very high. This is indicated by the R^2 of 96% and adjusted R^2 of 86%, respectively. Results of individual parameters reveal that under the PFMOLS, food production index had a positive and significant impact on life expectancy in the sampled countries. If food production index increased by one unit, life expectancy improved by 26%. The positive and significant impact of food production index on life expectancy finds support in the results of both panel dynamic OLS (DOLS) and panel OLS. Findings also reveal that under the PFMOLS, while GDP per capita had a negative and significant impact on life expectancy, government expenditure on health impacted positively and significantly on life expectancy. Results indicate that if GDP per capital rose by one unit, life expectancy dropped by 28%, but one unit increase in government expenditure on health improved life expectancy by 15%. All the regression models support the positive impact of government expenditure on health on life expectancy, even though the results for PDOLS and panel OLS are not significant. However, while result of PDOLS supports a positive impact of GDP per capita on life expectancy, even though the result is not significant, a significant and positive impact was observed under the panel OLS.

4.2 Discussion of Findings

From the results of the three models used in the paper, it is revealed that food production index impacted positively and significantly on life expectancy in the countries sampled. This implies that as the inhabitants of these countries produced and consumed nutritional foods, their life expectancy improved. This result finds support in two separate studies for Iran by Somayeh, *et al.* (2016) and Golkhandan (2019). Also, finding in Turkey by Gulcan (2020) corroborates this finding. Findings also show that food importation had a positive impact on life expectancy in all the models, even though the results are not significant. Due to food shortage in the countries sampled, food importation complements the shortfall in domestic supply. The study is of the view that the reason for the none-significant impact of food importation on life expectancy could be because majority of the food imported are processed with low nutritional value. The positive impact of food importation on life expectancy finds

support in Agu *et al*. (2020) in a study for Nigeria. In both PFMOLS and PDOLS, GDP per capita had a negative impact on life expectancy, even though the result is not significant under the PDOLS. The study is of the view that poor resource distribution which is a typical feature of most countries in Africa could be the reason for the negative result. In these countries, only a handful of individuals amass the resources meant for the citizens, while majority wallow in abject poverty. This finding finds support in a study for Nigeria by Aigheyisi (2020**)** and for Turkey by Gulcan (2020). However, Iran and the United States presented a different scenario as findings by Somayeh *et al.* (2016) and Ketenci and Murthy (2018) revealed a positive impact of GDP per capita on life expectancy for Iran and the United States, respectively. The positive impact of GDP per capita on life expectancy for the United States in particular shows how even distribution of resources which the developed countries are noted for, can improve life expectancy. Results of all the models employed in the study reveal that government health expenditure impacted positively on life expectancy and this is an evidence that all the health interventions by the government of these countries enhanced life expectancy within the study period. Findings of studies in Nigeria by Aigheyisi (2020**)** and Etikan *et al*. (2019) support this result.

Table 7. Results of PFMOLS, PDOLS and POLS

	PFMOLS			PDOLS			POLS		
Variable	Coeff	t-Stat	Prob.	Coeff	t-Stat	Prob.	Coeff	t-Stat	Prob.
FPI	0.26	12.5	0.00	0.25	5.68	0.00	0.26	9.80	0.00
FIMPT	0.11	1.29	0.19	0.08	0.76	0.44	0.03	0.45	0.64
LGDPPC	-27.8	-4.08	0.00	-9.99	-1.24	0.21	0.11	2.85	0.00
GEH	0.15	3.79	0.00	0.03	0.85	0.39	10.6	13.4	0.00
R^2	0.48			0.96			0.37		
AdjR^2	0.44			0.86			0.36		
Long-run variance	40.5			0.98					

5. Conclusion

This study aimed at investigating the impact of domestic food production on life expectancy in low income, food deficit African countries over the period from 2000-2020. Findings of the study indicate that in the entire three panel models used, food production index which proxies domestic food production had a positive and significant impact on life expectancy in the selected countries. Also, the study finds that while GDP per capita did not positively influence life expectancy; government expenditure on health improved it. Findings of the study therefore supported the various cohort studies reviewed that revealed a positive impact of the consumption of nutritional foods on life expectancy. Even though the study focuses on domestic food production, the fact that the countries in the sample usually produce the nutritional foods mainly for subsistence means that majority of the locally produced foods are consumed. The implication is that these countries should be encouraged, through appropriate policies; to improve the productivity of local foods rich in nutrients, while the importation of processed foods with low nutritional content should be curtailed. Equally, the study is of the view that government in these countries should step up health intervention programmes through raising the health budgets and monitoring the expenditure on health. Finally, the study advices that there is need to improve the institutions in these countries to ensure that corruption is reduced to minimum with a view to evenly distribute the wealth of the countries.

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Appendix i Low-Income Food-Deficit Countries (LIFDCs)

Africa	**Africa Contd.**	**Asia**
Benin	Lesotho	Afghanistan
Burkina Faso	Liberia	Bangladesh
Burundi	Madagascar	Republic of Korea
Cameroon	Malawi	Kyrgyzstan
Central African Republic	Mali	Nepal
Chad	Mauritania	Syrian Arab Republic
Comoros	Mozambique	Tajikistan
Congo	Niger	Uzbekistan
Côte d'Ivoire	Rwanda	Yemen
Democratic Republic of the Congo	Sao Tome and Principe	
Eritrea	Senegal	**Americas**
Ethiopia	Sierra Leone	Haiti
Gambia	Somalia	Nicaragua
Ghana	South Sudan	
Guinea	Sudan	
Guinea-Bissau	Togo	
Kenya	Uganda	
Tanzania		
Zimbabwe		

Source: Food and Agricultural Organization of the United Nations.