Obesity and Selected Health Outcomes in Sub-Saharan Africa: The Role of Regulatory Institutions

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Abstract
This study examines how regulatory institutions moderate obesity to influence health outcomes in Sub-Saharan Africa (SSA). The system generalized method of moment estimation technique was applied to a panel data spanning the period 2005-2019 for twenty-six (26) SSA countries. Diabetes prevalence, mortality due to cardiovascular diseases and life expectancy at birth were employed as health outcomes in the study. The findings indicate that regulatory institutions moderate the negative impact of obesity on the selected health outcomes and promote health. In fact, regulatory institutions alone as measured by the rule of law do not have any significant effect on health outcomes. However, when rule of law is interacted with obesity, it reduces diabetes prevalence and death due to cardiovascular diseases by 0.008 and 0.13 percentage points respectively. In addition, when regulatory institutions moderate obesity, it improves life expectancy by 0.09 year over the study period. The study suggests that government regulatory institutions in SSA should be equipped with the necessary tools and legislation to enable them perform their functions diligently. The institutions should also be given the requisite resources to ensure periodic institutional review of performance all aimed at improving health outcomes.

Introduction

Over the years, infectious diseases such as hepatitis and measles have been key contributors to the disease burden in Sub-Saharan Africa (SSA). Countries in this region, like other developing countries are undergoing change in disease burden. Non-communicable diseases (NCDs) are becoming more prevalent as compared to communicable diseases (Gouda et al., 2019). Obesity is linked to a high probability of diabetes and heart disease (Katz, 2000). Obesity occurs when there is a mismatch between the energy consumed in food and the energy expended. The difference in energy is retained in fat cells, which grow and/or multiply (Bray, 2004). According to the World Health Organisation (WHO, 2020) obesity is used for any individual with a Body Mass Index (BMI) of 30 kg/m^2 and above. Obesity prevalence has increased worldwide, reaching alarming proportions, particularly in developing countries such as SSA. Obesity in childhood is also a serious problem because children are more likely to grow up to be obese adults with comorbidities (Keller and Torre, 2015).

Increased consumption of sugar sweetened beverages (SSBs) has been associated with weight gain due to high energy levels and low nutritional content, among other things (Katz, 2000). Obesity, which is related to risk of diabetes, cancer and dental disease, has been related to an increase in body mass. Obesity rates in SSA are predicted to rise, resulting in higher health-care costs. Increased use of SSBs has led to increased obesity prevalence and increased risks of heart diseases around the world (WHO, 2017). Western and Middle Africa are among the African regions with the least rates of obesity incidence. North Africa and Southern Africa, on the other hand, are among the African regions with rising obesity rates. South Africa is one of the Southern African countries that have recently seen a surge in obesity rates (Myers et al., 2015).

Diabetes in SSA is also on the rise. Although advancement in age is still a threat for Type-2 diabetes, it is anticipated that, there will be a trend toward earlier onset. In 2013, the reported diabetes cases in Africa were among those below the age of 60, with peak onset occurring between 40 and 59 years. Obesity and diabetes are currently prevalent among children and adults aged 18 years and above in 2021 (WHO, 2021). By sex demographics, the number of women with diabetes is higher than that of men. This is so because women are more obese than men in the African sub region (IDF, 2019). These reports indicate that if nothing

is done to decrease the region's increasing use of SSBs, the detrimental impact on health will be severe in the coming years.

Many high-income and some middle-income nations are focusing public health efforts on ways to induce sugar consumption reduction through health policy, public education campaigns and formal education in order to combat the rising prevalence of obesity and Type-2 diabetes. Similar attempts, on the other hand, are not as developed or as forthcoming in SSA due to high rates of illiteracy and weak regulatory institutions. Health-care systems across SSA are unprepared to deal with epidemic levels of NCD, especially when seen in the context of the ongoing fight against infectious diseases. Muth et al. (2019), for instance, reported that SSB taxes were effectively used to address childhood obesity in the US, leading to the prevention of 575,000 cases of childhood obesity and a health care savings of $30.78 per dollar saved over 10 years. Thus, if these regulatory initiatives are implemented, it will help control or reduce the amount of energy intake of SSB's which in turn will help reduce the obesity level all other things being equal. Moreover, the WHO has recommended that governments should make settings where children meet be free from all unhealthy foods. They also added that regulatory policies for reducing diet-related diseases should be implemented.

In SSA, where a variety of marketing strategies targeted at younger people are used to assure brand awareness and influence purchase and brand loyalty, SSB already contribute significantly to total sugar and energy consumption. This, combined with a general lack of nutritional awareness or interest in preventative health, might lead to a young child's frequent ingestion of sugary drinks. To assist address this issue, they stated that enhanced efforts by governments and the nutrition community to educate the public on the health impacts of rising and excessive SSB consumption are required, and this calls for effective regulatory institutions

Literature Review

Few studies have examined the effect of obesity on selected health outcomes such as diabetes prevalence, CVDs and cancer in Africa. Agyemang et al., (2016) examined the prevalence of overweight and obesity in SSA, as well as their factors and links to CVDs and diabetes. Audain, Levy and Ellahi (2019) investigated the trends in early sugar-sweetened beverage (SSB) intake in SSA in the context of rising child and adolescent obesity and rising Type-2 diabetes prevalence. They examined ways to alleviate them, drawing on experiences from Africa and other parts of the world. The study suggested that SSB such as carbonated beverages and fruit juices, contribute to the development of obesity and related Non-Communicable Diseases (NCD). Msyamboza et al., (2013) corroborates that obesity is the most prevalent of the CVD risk factors among Malawian adults. When compared to people of normal weight, obese and overweight people had greater systolic and diastolic blood pressure, a potential predisposing factor for CVDs (Ayah et al. 2013).

In Tanzania, Njelekela et al., (2009) reports that a 1% rise in BMI was linked to a 10% increase in the risk of hypertension. In Nigeria, having a BMI of more than 25 raised the risk of hypertension by 12% (Okpechi et al, 2013). Furthermore, obese people had a higher risk of diabetes than persons of normal weight (Tibazarwa et al., 2009).

In a related study, Bray (2004) indicates that hypertension was prevalent in 44-51 percent of the patients in the Swedish Obesity study. According to estimates, controlling obesity would remove 48 percent of hypertension in whites and 28 percent of hypertension in blacks. The risk of myocardial infarction drops by about 2% for every 1 mm Hg reduction in diastolic blood pressure. The effects of obesity and hypertension on heart function are complex. Hypertension causes concentric hypertrophy of the heart and thickening of the ventricular walls in adults of normal weight. Eccentric dilatation occurs in overweight people while Hypertension is linked to increased prevalence of stroke. Coronary heart disease (CHD) is the main cause of death in affluent countries and one of the top causes of disease burden in developing countries (Gaziano et al. 2009).

Furthermore, Cresswell et al. (2012) investigated whether maternal obesity is a risk factor for newborn death in SSA as well as the impact it has on the precise timing of death during the neonatal period. A total of 27 SSA countries' cross-sectional demographic and health surveys (2003-2009) were merged. They employed multivariate logistic regression to analyze the risk of newborn death by obese mothers. After

controlling for confounding factors, maternal obesity was linked to a higher risk of newborn death. Obesity in the mother was found to be a substantial risk factor for newborn mortality in the first two days of life. Because of the insufficient statistical power, they found no statistically meaningful relationship later in the neonatal period. As a result, they came to the conclusion that maternal obesity is linked to an increased risk of early newborn death in SSA.

Despite the fact that there have been studies on obesity and its health effects in SSA, none of these studies have examined how government policies via its regulatory institutions help reduce obesity rates in SSA using the generalized method of moment (GMM) methodology. This study examines the effects of obesity on diabetes prevalence, mortality due to cardiovascular diseases and life expectancy. Second, we examine the effects regulatory institutions have on diabetes prevalence, mortality due to cardiovascular diseases and life expectancy and finally we examined how regulatory institutions moderate obesity on diabetes prevalence, mortality due to cardiovascular diseases and life expectancy. The study advances the literature on the effect of obesity on health outcomes by examining the role of quality regulatory institutions.

The rest of the paper is organized as follows. The next section discusses methodology and data requirements. Discussion of the results of the study continues thereafter and the final section summarizes the main findings and policy implications of the study.

Methodology and Data

Grossman's (1972) "demand for health" model which was later simplified and extended by Wagstaff (1986) is the underpinning theory for this study. Using the health production concept, we assume that people manufacture health by utilizing various socio-economic and non-socio-economic variables. Thus, health is a function of various health inputs which is mathematically written as:

Health = f (socio-economic and non- socio-economic variables) (1)

Health= f (E, I, O, H, D, R, B,……P) (2)

Where;

E= Education; I= Income; O= Occupation

H= Healthcare services

D= Diet; R= Recreation

B= Behavioral lifestyles such as alcohol consumption and smoking

P= Physical exercise

In line with the objectives of this study, we investigated the importance of regulatory institutions moderating obesity in achieving better health outcomes as shown below;

Health outcomes (HO) = ƒ (OB, LAW, Z) (3)

Where HO is the selected health outcomes (mortality due to CVD, diabetes prevalence and life expectancy)

OB is obesity prevalence

LAW is institutional/regulatory quality

Z is a vector of control variables

We then interact the variable LAW with OB in order to find out whether the strength of the relationship between obesity and the selected health outcomes is affected by the presence of regulatory institutions. According to the literature, the important variables that determine diabetes prevalence, CVD mortality, and life expectancy are the control variables. The variables are the percentage of the population living in cities (urbanization), GDP per capita, unemployment, immunization and the prevalence of undernourishment. The dynamic form of the model is as follows:

$$HO_{it} = \beta_0 + aHO_{it-1} + \beta_1 OB_{it} + \beta_2 LAW_{it} + \beta_3 OB_{it}*LAW_{it} + \beta_4 UnNOR_{it} + \beta_5 UnEMPLOY_{it} + \beta_6 UrPOP_{it} + \beta_7 GDPC_{it} + \beta_8 DPT_{it} + \varepsilon_{it} \quad (4)$$

Where, HO, OB and LAW are as previously defined.

HO_{it-1} and HO_{it} are the first lag and current levels of the selected health outcomes respectively,

OB LAW,* is the interaction (product) of obesity prevalence and institutional quality,

DPT is the percentage of population who have been immunized

UrPOP, is the percentage of the population living in urban areas,

GDPC, is gross domestic product per capita,

UnEMPLOY, is the rate of unemployment
UnNOR, is the percentage of the population who are undernourished,
β_0, is the intercept,
ε, is the random error term,
it, refers to country i (i=1 . . . 26) at time t (t=2005 . . . 2019) and
$\beta_0 \ldots \beta_9$, are all coefficients.

Dependent Variables

Mortality from cardiovascular (MCVD): CVDs are a group of heart and blood vessel problems. Obesity is a major contributor to these deaths. This was measured by the percentage of the population dying from cardiovascular diseases.

Diabetes prevalence (Diabetes): Diabetes is a condition in which your blood glucose, often known as blood sugar, is abnormally high. High glucose levels are linked to long-term harm to the body and the failure of many organs and tissues (WHO, 2021). This was also measured by the percentage of the population between the ages of 20 to 79 who have diabetes.

Life expectancy (LE): The term "life expectancy at birth" refers to how long a newborn infant would live if current mortality statistics at the moment of birth remained constant throughout his or her life. It has been widely accepted in the literature as the most reliable and consistent indicator of overall health (Nixon and Ulmann, 2006). To account for the whole health situation of the countries under consideration, life expectancy at birth was chosen.

Independent variables

Obesity prevalence (OB): Obesity is used as one of the explanatory variables because obesity is a risk factor for majority of CVDs that affects health. Hence, we predict obesity to raise diabetes, CVD-related mortality, and shorten life expectancy. This was measured by the percentage of the adult population who are obese.

Institutional quality (LAW): The effectiveness of policies and institutions has a significant impact on the degree to which quality institutions enhance health status. We utilize Douglas North's definition of institutions, which asserts that institutions are those formal and informal standards of procedure, as well as the enforcements that go along with them (North, 1991). The World Bank worldwide governance indicator has identified six different indicators as a way of measuring the quality of governance in various countries across the globe. Voice and Accountability, Political Stability, Government Effectiveness, Rule of Law, Regulatory quality and Control of Corruption are the various indicators proposed by the World Bank. This study used rule of law as the measure for institutional/regulatory quality. This measure was used because it offers a detailed measure of the extent to which countries adhere to the rule of law in practice places strong emphasis on institutional frameworks and how they function which is in line with the objective of this study.

Child immunization measures the percentage of children aged 12-23 months who received vaccinations before 12 months or at any time before the survey. A child is considered adequately immunized against diphtheria, pertussis (or whooping cough), and tetanus (DPT) after receiving three doses of vaccine. This variable was added as a control variable because vaccines help the immune system to be stronger thus helping people live longer.

Unemployment was used a control variable because it has adverse effects on health. Smoking, alcohol consumption and stress are increased after the onset of unemployment which decreases life expectancy. Also, *urbanization* poses health problems such a poor nutrition, diabetes and communicable diseases. Since diabetes and life expectancy are used as dependent variables in this study, urbanisation was added to control for its effect on these dependent variables. Several studies, including Musgrove (1996) and Gupta et al. (2002), imply that as a nation's per capita income rises, so does its population's health. This emphasizes the importance of GDP per capita in affecting health condition. Finally, *undernourishment* was included to account for the impact of diet on health outcomes.

Estimation Technique

The presence of potential endogeneity in the model makes using OLS to estimate the model difficult: the results will be inconsistent and biased. Although alternative estimation strategies exist to deal with the endogeneity problem, the dynamic panel model works best with the Generalized Method of Moment (GMM) estimation technique because it can handle the dynamic panel bias problem caused by endogeneity. Important approaches for estimating the model include the use of Instrumental Variable (IV) and Two-Stage Least Squares (2SLS) estimates. Both techniques, however, rely on external instruments. The problem with employing external instruments is that they are frequently ineffective and cannot meet the "validity and relevance" criterion, resulting in an impartial estimate (Blundell & Bond, 1998). Again, obtaining instruments that are associated with endogenous variables while being uncorrelated with stochastic error terms is a challenge. In this case, the GMM approach is the better option since it makes use of the lags of the endogenous variables as the instruments. According to Blundell and Bond (1998), the system GMM employed in this study makes an assumption about the initial circumstances in order to obtain moment conditions that are useful for even persistent series and have been proved to perform well in simulations.

Data

The data on institutional quality came from the World Bank's governance indicators' rule of law component, while the rest of the data on both dependent and control variables came from the World Bank's World Development Indicators, which covered 26 SSA nations from 2005 to 2019. The countries were chosen based on the availability of data. Countries in the region that lacked data for either of the dependent variables or the variables of interest were left out. Countries that lacked data for more than one of the control variables were also eliminated.

Results and Discussion

The study covered twenty-six (26) SSA countries spanning the period 2005 to 2019. The empirical estimations were computed using StataCorp's statistical software version 13.1 (STATA 13). The results from the multicollinearity test (see Table 3 in appendix) revealed that there was no significant correlation between the variables; however, the heteroskedasticity test (see Table 4 in appendix) rejected the null hypothesis of constant variance for all equations. The endogeneity test (see Table 5 in appendix) on the other hand, indicated that the rule of law, per capita income, and immunization are all endogenous with diabetes prevalence and life expectancy. At a 1% level of significance, the inverse chi-squared test revealed that none of the variables have a unit root.

All the selected SSA countries had information on all of the variables making the panel balanced. From Table 1, the average values for the dependent variables: mortality due to cardiovascular diseases, diabetes prevalence and life expectancy are 24.54, 7.2 and 59.18 respectively. This means 24.54% of population die from cardiovascular diseases on average in SSA and 7.2% of the population between the ages of 20 and 79 on average have diabetes in SSA. Life expectancy on average in SSA however is 59 years. The percentage of children who were immunized had a minimum and maximum value of 36 and 99 respectively. Obesity had a 28.59 percent average rate. LAW had a 5.48 mean value and a 0.53 standard deviation

Table 1: Summary statistics of all variables used in the estimation

Variable	Mean	Std. Dev.	Min	Max
Mortality from CVD (MCVD)	24.54	5.51	15.9	48.1
Diabetes	7.2	1.7	3.3	13.5
Life expectancy (LE)	59.18	5.97	42.60	74.51
Obesity (OB)	28.59	7.23	15.9	55.1
Rule of law (LAW)	5.48	0.53	4.52	7.03
Per Capita Income (GDPC)	2165.57	2529.61	162.43	11208.34
Undernourishment (UnNOR)	19.32	10.63	3.5	52.2
Unemployment (UnEMPLOY)	7.86	7.01	0.8	30.78
Urban Population (UrPOP)	43.33	16.95	15.05	89.74
Immunization (DPT)	81.07	13.80	36	99

Source: Authors' Computation Using Stata 13.1

Table 2: GMM estimates of the effects of obesity, regulatory institution and interaction of regulatory institution and obesity on life expectancy, diabetes prevalence and mortality due to CVDs in SSA.

VARIABLES	(1) LE	(2) Diabetes	(3) MCVD
LLE	1.003***		
	(0.00348)		
OB	-0.548***	0.0344*	0.765***
	(0.0466)	(0.0195)	(0.288)
LAW	-2.810***	0.294***	3.904***
	(0.228)	(0.113)	(1.458)
OB*LAW	0.0925***	-0.00767**	-0.131***
	(0.00758)	(0.00337)	(0.0474)
UnNOR	0.00610***	0.000495	-0.0175
	(0.00130)	(0.00106)	(0.0112)
UnEMPLOY	0.0253***	0.0137***	-0.00394
	(0.00320)	(0.00250)	(0.0297)
UrPOP	0.00508***	0.00349***	-0.00685
	(0.00164)	(0.00116)	(0.00579)
GDPC	-0.209***	-0.0501***	-0.0927
	(0.0442)	(0.0140)	(0.0881)
DPT	0.00944***	-0.00142**	-0.0101*
	(0.00207)	(0.000553)	(0.00515)
	(0.0589)	(0.0304)	(0.258)
LDiabetes		0.998***	
		(0.00514)	
LMCVD			1.043***
			(0.0250)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

From our results, obesity has a negative and significant effect on life expectancy and a positive and significant effect on mortality due to cardiovascular diseases and diabetes prevalence. A percentage point increase in obesity rate in SSA will lead to a 0.55 year decrease in life expectancy all other variables held constant. This corroborates findings from Peters et al. (2003), Lartey et al. (2020) and Adair and Lopez (2020). Diabetes prevalence and mortality due to cardiovascular diseases will also increase by 0.03 and 0.77 percentage points respectively as obesity rate increases by one percentage point. The coefficients were statistically significant at 1%, 10% and 1% respectively. Obesity decreases life expectancy because obese individuals are at a higher risk of developing so many other medical complications such stroke and CVDs. This results in the probability of early deaths thus decreasing life expectancy. This meets our a priori expectation because theoretically, using the health production function, an individual combines both socio-economic and non-socio-economic factors to produce health. Hence, all other factors equal, if these health inputs are positive, we expect an individual to be healthy. On the contrary, obesity mainly is as a result of consuming a lot of SSB's and fatty foods. Since these inputs are detrimental to the health of an individual, we expect adverse effects on our health outcome measures. Obesity in adulthood is linked to shorter life expectancy and higher rates of early mortality. These decreases in life expectancy are comparable to those reported in smokers. Obesity and its associated health impacts are becoming more common among older persons in resource-poor nations (Lartey et al., 2020).

Obesity is also a risk factor for diabetes, and being obese is the sixth most important risk factor contributing to the worldwide disease burden (Tibazarwa et al., 2009). The association between SSB's and obesity has long been known. Our findings revealed that, if all other factors remain constant, a percentage point increase in obesity rate will result in a 0.03 percentage point increase in diabetes prevalence in Sub-Saharan African countries. This happens because obesity leads to the development of insulin resistance which is a precursor for Type 2 diabetes. This was supported by Audain et al. (2019), who found that a 1%

increase in SSB consumption was connected to an additional 0.3 diabetic adults per 100 people in 165 countries. Obese individuals also had a higher risk of diabetes than normal-weight people (Tibazarwa et al., 2009).

Obese individuals also have more CVD risk factors than healthy people (Ayah et al., 2013, Njelekela et al., 2009). Our findings did not prove otherwise. A percentage point increase in obesity rate increases mortality due to cardiovascular diseases by 0.77 percentage point in SSA. This occurs because obesity leads to structural and functional changes of the heart leading to heart failure. Obesity was shown to be the most common CVD risk factor. In Tanzania, a 1% increase in BMI was associated with a 10% increase in the risk of hypertension (Njelekela et al., 2009). A BMI of greater than 25 increased the risk of hypertension by 12% in Nigeria (Okpechi, 2013). This means that weight-loss-promoting policies and procedures must be introduced as soon as possible in the region. Adult obesity is a strong predictor of death at a later age. Obesity prevention and treatment should be given prominence in public health as the prevalence of the epidemic rises. The impact of adult obesity on life expectancy and early death is dramatic.

Table 2 also revealed that, holding other variables constant, the presence of rule of law has a positive and significant influence on mortality due to cardiovascular diseases and diabetes prevalence, as well as a negative and significant effect on life expectancy. Even though we expected rule of law which represents institutional quality to have positive and significant effect on life expectancy and a negative and significant effect on mortality due to cardiovascular diseases and diabetes prevalence, our findings proved otherwise. A unit increase in rule of law holding all other variables constant decreased life expectancy by 2.8 years and increased diabetes prevalence and mortality due to CVDs by 0.29 and 3.90 percentage points respectively. These coefficients were statistically significant at 1%. This showed that the presence of rule of law does not necessarily have positive impact on health outcomes. It has to be moderated with a variable of interest (obesity) in the case of our study through which it will have a positive impact on health outcomes. Hence, according to our findings, holding all other variables constant, rule of law moderating obesity reduces diabetes prevalence and death due to cardiovascular diseases by 0.007 and 0.13 percentage points respectively. Also, it results in a 0.09-year improvement in life expectancy in SSA. These coefficients were also statistically significant at 5%, 1% and 1% respectively. The results demonstrated that the interacted variable's moderating role in influencing obesity is extremely important in having a positive impact on health outcomes. The interaction of obesity and quality regulatory institutions, as measured by the rule of law, is crucial in reducing diabetes prevalence and death from cardiovascular diseases, as well as improving life expectancy. Given the high incidence of obesity, our findings demonstrated that effective institutions are critical in achieving better health outcomes. Pinzon-Rondon et al. (2015) opined that institutions, rather than any other variable capable of predicting health outcomes, play a major role in achieving better health outcomes. As a result, countries with stronger regulatory institutions will have lower SSB intake and thus lower obesity rates, while countries with weaker regulatory institutions will have higher SSB consumption and obesity rates all other things being equal.

Conclusion and Policy Implications

Obesity prevalence must be reduced in order to have improved health outcomes, according to the literature. This alarming situation prompted this research into how quality regulatory institutions might help the region achieve better health outcomes through reduction in obesity prevalence. As a result, many governments across the globe, particularly those in SSA, must commit major amounts of their revenues to strengthening their regulatory institutions to aid reduce obesity prevalence. Obesity prevalence has a negative significant influence on life expectancy and a positive significant effect on mortality due to cardiovascular diseases and diabetes prevalence, according to our findings. A percentage point increase in obesity rates in SSA will lead to a 0.55 year decrease in life expectancy all other variables held constant. Diabetes prevalence and mortality due to cardiovascular diseases will also increase by 0.03 and 0.77 percentage points respectively as obesity rate increases by a percentage point. In terms of the interacting variable (rule of law), it was discovered that, holding all other variables constant, rule of law moderating obesity reduces diabetes prevalence and death due to cardiovascular diseases by 0.007 and 0.13 percentage points respectively. Also, it results in a 0.09-year improvement in life expectancy in SSA. These coefficients were also statistically significant at 5%, 1% and 1% respectively.

Given the findings of this study, SSA's regulatory institutions should be enhanced by establishing clear policies on norms and processes to be followed in order to achieve the goal of lowering obesity prevalence in the region. To manage the amount of sugar in their beverages, regulatory agencies must oversee the sugar sweetened beverage industry. This is critical because the use of SSBs is a major contributor to rising obesity rates in SSA. This calls for minimizing corruption and providing management of the various health-care organizations with the resources and authority they require to carry out their duties.

Limitation and direction for future research

We do not recommend generalizing the findings due to the small number of SSA countries (26) considered in the study. As a result, the conclusions of this study are confined to the countries examined. Data on SSB's was unavailable impacting on the results of this research. We propose that more studies be conducted at the individual country level to capture how regulatory institutions and education can influence obesity in reducing diabetes prevalence and mortality due to cardiovascular diseases as well as increasing life expectancy. Childhood obesity is on the rise hence future research should focus on the effects of childhood obesity and its health consequences in SSA. Furthermore, we also recommend future researchers to analyze the healthcare cost imposed by obesity in SSA. Moreover, due to the increasing prevalence of cancer in SSA, obesity has been observed to be one of the key factors to cancer deaths, hence further research should focus on economic cost incurred on cancer treatment due to obesity prevalence in SSA.

APPENDIX

Table 3: Correlation matrix

	OB	LAW	UnNOR	UnEMPLOY	UrPOP	GDPC	DPT
OB	1.0000						
LAW	0.3683	1.0000					
UnNOR	-03684	-0.3568	1.0000				
UnEMPLOY	0.7595	0.3346	-0.2508	1.0000			
UrPOP	0.6517	-00606	-0.2200	0.4529	1.0000		
GDPC	0.6368	0.4838	-0.2826	0.5361	0.6219	1.0000	
DPT	0.1289	0.5844	-0.0977	0.0795	-0.2035	0.0198	1.0000

Source: Authors' Computation using Stata 13.1.

Table 4: Breusch-Pagan/ Cook- Weisberg test for heteroskedasticity

Null Hypothesis (H_O): Constant variance (homoskedasticity is present)

Alternative Hypothesis (H_A): Heteroskedasticity is present

Null Hypothesis: Constant variance		
Output for MCVD	chi2 (8) =	249.69
Prob>chi2 =	0.0000	
Output for Diabetes	chi2 (8) =	271.61
Prob>chi2 =	0.0000	
Output for LE	chi2 (8) =	206.60
Prob>chi2 =	0.0000	

Source: Authors' Computation Using Stata 13.1

Table 5: Durbin- Wu Hausman (DWH) Test for Endogeneity

Null Hypothesis	**P-value (Prob> Chi2)**
LAW	0.0000
GDPC	0.0000
UnNOR	0.0000
UnEMPLOY	0.0000
DPT	0.0000
UrPOP	0.0005

Source: Authors' Computation Using Stata 13.1

Table 5 shows that LAW, GDPC, UnNOR, UnEMPLOY, DPT and UrPOP are endogenous. Thus, they are specified in the GMM for their respective dependent variables with which they are endogenous.

Table 6: List of countries

Angola, Benin, Botswana, Burkina Faso, Congo Republic, Cameroon, Cote D'Ivoire, Ethiopia, Gabon, The Gambia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mali, Mauritania, Mauritius, Mozambique, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Tanzania and Togo.

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