National Income and Malnutrition in Africa: a Rapid Assessment

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Abstract

This paper pursues a simple analysis of a static relationship between national income and income distribution, and obesity/overweight and undernutrition in African countries. From intuition, a relation between national income (GDP/Capita) and malnutrition is expected. Countries that have higher income are expected to have higher prevalence of obesity/overweight. Likewise, countries with higher income should have lower levels of undernutrition. This paper tests this hypothesis using macroeconomic data. The paper also analyses the role of income inequality, as measured by the GINI coefficient, as a potential driver of malnutrition. In this case, countries that have high levels of income inequality are expected to have coexistent high levels of both obesity and undernourishment. Results of this analysis show that there is a correlation between income and malnutrition. However, this relationship is weak, with a correlation coefficient of less than 50% for both undernourishment and overweight/obesity. However, the signs are as expected, even when running a simple regression of the variables. Higher national income has a positive relationship with obesity and negative relationship with undernourishment. From the regression, only the coefficient on undernourishment is significant at 5% confidence level. No significant relationship was found between income distribution and malnourishment, even on the extended logistic model. These finding are not realistically surprising. Higher income does not guarantee good nutrition, although poorer countries are expected to have high level of undernourishment. Also, there is a friction in the response of undernutrition to growth in GDP. Given the low-income elasticity of demand for food, higher income is not expected to be strongly linked to obesity. This could also be an explanation for the low response of malnutrition to income inequalities, although this latter relationship needs to be tested further with data sets of longer duration, in a time series approach. As such, it is important to lobby governments to mainstream food and nutrition security in other initiatives that increase national income, and to promote direct interventions that reduce the prevalence of undernourishment as part of meeting the Sustainable Development Goals (SDGs). This will ensure that high national income translates to reduction in malnutrition prevalence across countries.

Key words: Malnutrition; Obesity; Undernourishment;* GDP/Capita*; GINI Coefficient

1. Introduction

The State of Food and Nutrition Security in the World (2018) reported that the absolute number of undernourished people, i.e. those facing chronic food deprivation, has increased to nearly 821 million in 2017, from around 804 million in 2016. Africa remains the continent with the highest Prevalence of Undernourishment, affecting almost 21 % of the population (more than 256 million people). These disturbing statistics pose major challenges for the continent to eliminate hunger by 2030, as part of its Sustainable Development Goals (SDGs) agenda. The SDGs offer new impetus for Africa to eliminate poverty and hunger and be on a sustainable socio-economic growth path. The region missed many to the Millennium Development Goals (MDGs), especially those linked to poverty and hunger.

According the MDG Report (2015), MDG1, which was the eradication of extreme poverty and hunger, was off-track in Africa. MDG1 was strongly and directly linked to agricultural development and food and nutrition security. The report noted that poverty in Africa excluding North Africa declined from 56.5 % in 1990 to 48.4 % in 2010, which was a far cry from the target of reducing it by half by 2015. It was further noted that in most parts of Africa, poverty was being perpetuated by rising inequality, unemployment and the youth bulge, conflicts and adverse weather conditions related to climate change.

Concerning hunger, the MDG Report noted that hunger statistics declined by 8 % in Africa, excluding North Africa, between 1990 and 2013. This observation notwithstanding, sub-Saharan Africa remained the most food deficient of all regions of the world, with 25 % of its population facing hunger and malnutrition in 2011-2013, and with many living below the minimum dietary energy consumption.

These suborn hunger and malnutrition statistics persist despite the growth in GDP in Sub-Saharan Africa since 2001. Growth in African real GDP was estimated at 3.6%, higher than the 3.1% for the global economy and 1.5% for the euro area. Africa remained the world's second fastest growing economy after East Asia (African Economic Outlook, 2016).

Malnutrition, which often refers to undernutrition and hunger, also manifests itself as overweight and obesity. Given Africa's rapid economic growth in recent years and the expanding middle class, there is now a growing problem of overnutrition. This is fueled by urbanization and mushrooming of fast food outlets in urban areas. The combination of persistent poverty and rapid economic growth means that undernutrition and obesity/overweight tend to co-exist in many African countries. It is without doubt therefore that African malnutrition statistics are related to national incomes, but the question is what form does this relationship take? It is also hypothesized that income in-equality could explain the co-existence of under- and over-nutrition, but is this the case in Africa in general?

2. Literature review

Malnutrition and Income

Intuition dictates that there should be a link between national income and malnutrition. National income (as measured by GDP per Capita) and income distribution in general is a key determinant of wellbeing of countries and their citizens. It is an indicator of literacy rates, healthcare systems, infrastructure, ICT, and other industrial development parameters and also, food and nutrition security status of the population.

However, for many studies, food and nutrition security indicators are often associated with agricultural development. They are rarely analysed in line with development indexes of other sectors of the economy, except maybe health and social welfare. This lack of alignment of food and nutrition security indicators to the other economic sectors that ensure national wellbeing tend to isolate agriculture and make it appear like a standalone sector. This marginalises it in national investment decisions and in general, this tends to fuel malnutrition.

Studies that link malnutrition and income are diverse and tend to be focussed on household income rather than national macroeconomic indicators. There is less focus on the relationship between malnutrition and income, including income distribution, at macro or national level. Many of these studies are also silent on income distribution as a driver of malnutrition at national level. In this paper, malnutrition refers to both undernutrition and over nutrition.

For example, according the hypothesis put forward by Simon Kuznets' (1955) on progress of economic development and income inequality, a natural cycle develops where inequality first increases with economic development, then decreases after sometime. Extending this hypothesis to an "Obesity Kuznets curve", Anca and Rotthoff (2015) postulated that as incomes rise, resources become available to buy more food. As such, people consume more calories and obesity rates increase. However, as incomes continue to rise, personal health becomes a more valued asset and people decrease their obesity levels.

Chang and Lauderdale (2005) studied the link between obesity and income in the USA. The study found that over the course of 3 decades, obesity has increased at all levels of income. The increase in obesity was higher in the groups with higher income. For example, among black women, the absolute increase in obesity was 27.0% (1.05% per year) for those at middle incomes, but only 14.5% (0.54% per year) for the poor. Among black men, the increase in obesity was 21.1% (0.77% per year) for those at the highest level of income, but only 4.5% (0.06% per year) for the near poor and 5.4% (0.50% per year) for the poor.

Vollmer et. al. (2014) used DHS data from many countries to conclude that there was no evidence of link between economic growth and early childhood undernutrition. However, O'Connell and Smith (2016) used their own investigation to dispute this lack of linkage and found a significant association between economic or income growth and undernutrition, which was stronger once issues of measurement error, duration, and influence were taken into consideration.

Dinsa et. al. (2012) found that in low-income countries or in countries with low human development index (HDI), the association between socio-economic status and obesity appears to be positive for both men and women; the more affluent and/or those with higher educational attainment tend to be more likely to be obese. However, in middle-income countries or in countries with medium HDI, the association becomes largely mixed for men and mainly negative for women. By contrast, obesity in children appeared to be predominantly a problem of the rich in low- and middle-income countries. These conclusions were reached from analysis of 72 papers

that link socio-economic status and malnutrition indicators, such studies having been conducted around various regions of the world.

Haddad et. al. (2003), using a four round panel data set from northwestern Tanzania, concluded that better nutrition is associated with higher income, and that nutrition interventions have a substantial beneficial effect.

Svedberg (2004), using data from 1980s up to 2003, spanning more than 100 developing countries –tested the basic hypothesis of whether the relationship between undernutrition (child stunting and underweight) and real income has changed during the past decade. The study found a statistically significant correlation between child undernutrition and real income, with and adjusted R- square of 0.536. This means that more than half the variation in child stunting across countries is "explained" by the income variable alone.

Alderman et. al., (2005) wanted to find out how rapidly child malnutrition respond to GNP growth by exploring household data from twelve countries. In addition, data on the malnutrition rates since the 1970s available from a cross-section of countries was employed in this investigation. Both forms of analysis yielded similar results. Income increases at the household and at the national level imply similar rates of reduction in malnutrition at the same rate of increase income. However, the study also concluded that goals of halving the levels of child malnutrition in the first two decades of this century set by the 1990 UNICEF World Summit on Children or the 1996 FAO-WHO World Food summit were unlikely to be met through income growth. Thus, a combination of growth and specific nutrition programs would be needed.

Hagey (2012) noted that despite the effect of economic growth on malnutrition, national income levels were not the only factors contributing to malnutrition. He noted that some countries have lower levels of stunting, or chronic malnourishment, than their gross national income (GNI) would suggest, while others are experiencing dramatically high levels of stunting for their income level, thus showing a mixed picture.

Picket et. al. (2004) on their study on top 50 countries with highest GNI per capita by purchasing power parity in 2002 observed that obesity, diabetes mortality, and calorie consumption were associated with income inequality in developed countries, and that increased nutritional problems may be a consequence of the psychosocial impact of living in a more hierarchical society.

Babey et. al. (2010) assessed income-specific trends in obesity rates among a diverse population of California adolescents using data from 17 535 adolescents who responded to the California Health Interview Survey between 2001 and 2007. Their study found that between 2001 and 2007, obesity prevalence significantly increased among lower-income adolescents but showed no statistically significant difference among higher-income adolescents after adjustment for age, gender, and race/ethnicity. Monteiro (2001) found that in 1997, Brazilian low-income women were significantly more susceptible than high-income women to both underweight and obesity.

Kim and von dem Knesebeck (2018) explored the direction of the causal relation between income and obesity by specifically assessing the importance of social causation and reverse causality in the USA. Their study concluded that there is more consistent evidence for reverse causality, i.e. obesity was not found to result in lower income.

Ljungvall and Gerdtham (2010), using longitudinal data over a 17-year period for a Swedish cohort aged 20–68 in 1980/1981, analyzed income-related inequalities in obesity, and found that among females, inequalities in obesity favor the rich, but the inequality declines over time.

Larrea and Kawachi (2004) examined the association between economic inequality and child malnutrition in Ecuador. Economic inequality was measured by the Gini coefficient of household per capita consumption, estimated from the 1990 Census. After controlling for relevant covariates, the study found that economic inequality at the provincial scale had a statistically significant deleterious effect on stunting. At municipal or local levels, inequality was not associated with stunting.

The selected studies show a mixed picture of the relationship between income/income distribution and malnutrition, but there is a general census that income and malnutrition are related. This study will add to the battery of finding by determining the basic relationship between malnutrition indicators and national income for African Member States where suitable data is available.

3. Study Rational and Methodology

The 2030 Agenda for Sustainable Development and the UN Decade of Action on Nutrition 2016–2025 call on all countries and stakeholders to act together to end hunger and prevent all forms of malnutrition by 2030. This will require multi-pronged approaches that are not focusing only on the farm and foods systems but also on other sectors that contribute to national development. Within the context of Africa, African Union (AU) Member States made commitments to eliminate child under-nutrition with a view to bringing down stunting to 10% and underweight to 5% by 2025. This is part of the Comprehensive Africa Agricultural Development Programme (CAADP) under the Malabo Commitments.[1] These African commitments to reduce malnutrition are also enshrined in the African Region Nutrition Strategy (ARNS, 2015-2025).[2] The achievements of these malnutrition reduction targets will depend on multi-stakeholder approaches, and agriculture and food systems stand to play a crucial role, together with interventions in other sectors like health and education.

It is well known that food and nutrition security does not only depend on national ability to produce food but also on national ability to acquire food. The ability to acquire food depends on national income. This is the case also at household level. A simple case in point is that urban dwellers do not produce any food but still they are able to acquire food using their income which ensures their food and nutrition security. However, someone has to produce the food off course but food producers are not necessity the ones who are food secure.

[1] The Comprehensive Africa Agriculture Development Programme (CAADP) is Africa's policy framework for agricultural transformation, wealth creation, food security and nutrition, economic growth and prosperity for all. In Maputo, Mozambique, in 2003, the African Union (AU) Summit made the first declaration on CAADP as an integral part of the New Partnership for Africa's Development (NEPAD).

[2] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=2ahUKEwi9ncvOh-rdAhVkDMAKHZTUCY0QFjABegQICBAC&url=http%3A%2F%2Fwww.who.int%2Fnutrition%2Ftopics%2FAfrican_Nutritional_strategy.pdf&usg=AOvVaw0AyYmCluKD4Z8yO94KbV4x

The relationship between food and nutrition security and income is a particularly pertinent one given the sad observation that in Africa, small-scale farmers produce up to 70 % of food, yet this is the population strata that is trapped in poverty. This brings about the intricate link between income and food and nutrition security, which need to be analyzed in more details.

Nutrition sensitive agricultural investments must be designed with the aim of ensuring income generation. This argument adds to the approach of building a strong business case to food production systems. It is not only the food produced that is important but also income to acquire the food. In other words, food and nutrition security initiatives must be market led or market oriented. Building an economic case in food systems is one key pillar to ensure their sustainability. Adequate income also ensures dietary diversity.

The coexistence of undernutrition and obesity at national level has a lot to do with income and income distribution but these nexuses have not been interrogated well. The co-existence of these two malnutrition conditions is a macro-economic policy issue that needs to be addressed. Factors such as access to quality health care services and education have been well documented and linked to national income but malnutrition indicators tend to be constrained at household level with poor linkages to the broader national economy. Despite the paucity of studies to prove it, food and nutrition security has strong linkages to other macro-economic development indicators like infrastructure, ICT, clean water and electricity for example.

In this regard, it is of interest to perform a quick analysis to determine the relationship between national income (and income skewness) and malnutrition at macro-level rather than at household level. This analysis will help inform policy in that it will re-orient thinking towards mainstreaming food and nutrition security into other national development initiatives that increase national income besides the agricultural sector. Progress in other sector other than agriculture also plays a crucial role in ensuring national food and nutrition security, and this must be realised when designing national development policies and strategies, and in promoting nutrition sensitive investments.

The level of a country's income determines the amount as well as composition of its food demand. On average, high-income countries spend 16% of their incomes on food while low-income countries spend 55% (Regmi et. al., 2001).

Given these observations, this quick analysis aims to answer the following questions:

- What is the relationship between national malnutrition statistics and national income in African Union Member States?
- Is the coexistence of undernutrition and obesity/overweight related to national income distribution, as measure by the national GINI Coefficient?

The analysis will first determine if there a correlation between GDP per Capita and Malnutrition Indicators; and between the GINI Coefficient and Malnutrition Indicators. Following this, regression models will be run to determine the relationship between these macro-economic indicators and malnutrition. This analysis will follow a simple regression as shown in equation below:

$$Y_i = \beta_i x_i$$

Where;

Y_i is the dependent variable

β_i is a vector of regression coefficients

x_i is a vector of observed covariates

Using the simple regression equation above, three regressions are run;

For the first analysis, the aim is to find the relation between the GINI Coefficient as an dependent variable (Y_i) and Underweight and Obesity as the independent variables (x_i).

For the second analysis, the aim is to find the relation between GDP per Capita as the dependent variable (Y_i) and Underweight and Obesity as the independent variables (x_i).

The last regression is to use GDP per Capita as the dependent variable(Y_i); and Underweight, Obesity and GINI (x_i) as the independent variables. The aim of the last regression is to find out how GDP per Capita drives malnutrition while controlling for income inequalities. All the variables are transformed to log forms so that the elasticities are interpreted as percentage changes for a 1% change in the independent variable.

To make the analysis more robust we run a logistic regression model instead of OLS for the relationship between GINI Coefficient and Malnutrition. Both these variables, the GINI Coefficient and Malnutrition can only take values between 0-1, strictly speaking. In this way, they take the form of a probability distribution. Before the regression is run, the GINI Coefficient is transformed to take a value of 0 if it is ≤0.5 or a value of 1 if it is >0.5 for a given country. The logistic model is based on the equation below:

$$log\frac{Y(x)_i}{1-Y(x)_i} = \beta_0 + \beta_i x_i$$

The logit function is the natural log of the odds that Y equals 1, where Y only takes the dichotomous values 0 and 1. The logistic regression has been used by many scholars. Some of its theoretical founding has been discussed by Agresti (2002), and Hosmer and Lemeshow (2000) for example.

4. Data

The data for the analysis is obtained from WHO, and the World Bank statistics for African Member States. It is a snapshot analysis with the base year of 2010. The underweight statistics are for children under the age of 5years while the overweight/obesity statistics are for individuals between the ages of 2-19 years.

The overweight/obesity statistics are obtained from Health Intelligence, following the link below.

http://publichealthintelligence.org/content/prevalence-overweight-and-obesity-worldwide

Overweight/Obesity is defined as individuals with a BMI>= 25Kg/M^2

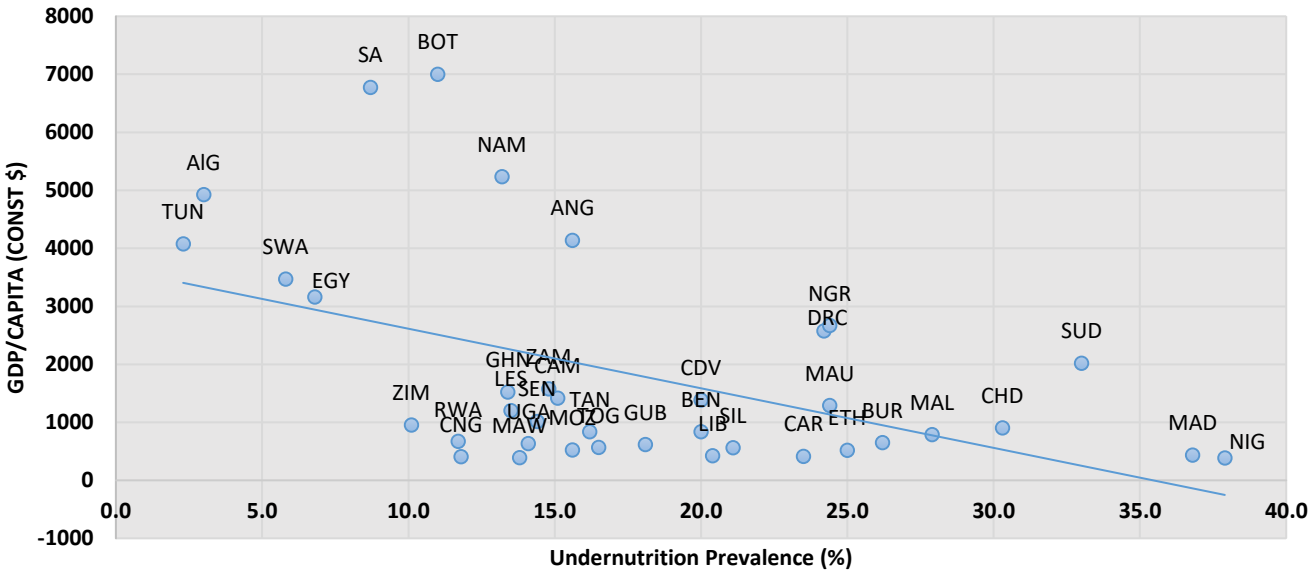
5. Empirical Findings and Discussion

Intuition dictates that nations with a higher income should have higher obesity/overweight prevalence than nations with low income. The same is true for underweight. Nations with low

income are expected to have higher prevalence of underweight than nations with higher income. This intuition is tested first using a simple correlation analysis between income and malnutrition indicators.

Figure 1 below is a plot of Undernutrition and National Income.

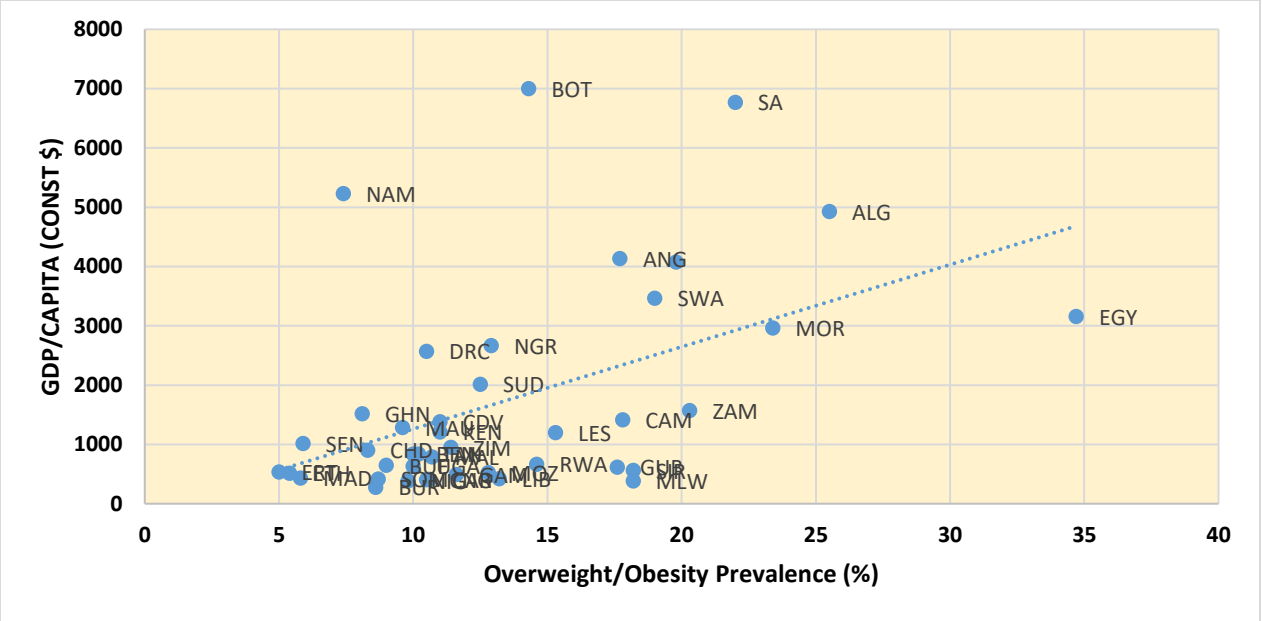
Figure 1: Relationship between Undernutrition and National Income



The plot above shows a clear negative relationship between undernutrition prevalence and national wealth, measured in GDP per Capita in constant USD. The correlation coefficient between the two variables is -0.48665, which is significant. However, the correlation is still less than 50%.

A plot of the relationship between national income and obesity/overweight is also undertaken. The results of this plot are shown in Figure 2 below.

Figure 2: Relationship between Obesity/ Overweight and National Income



The plot shows a positive relationship between national income and obesity/overweight. The correlation coefficient is again significant at 0.47921263. As seen in the graph above, and the value of the correlation coefficient, which is below 50%, there is evidence the observation by the WHO that obesity is becoming common in low and middle-income countries. This is supported by the equally low correlation between undernutrition and national income.

The WHO (2018) noted that many low- and middle-income countries are now facing a "double burden" of disease.

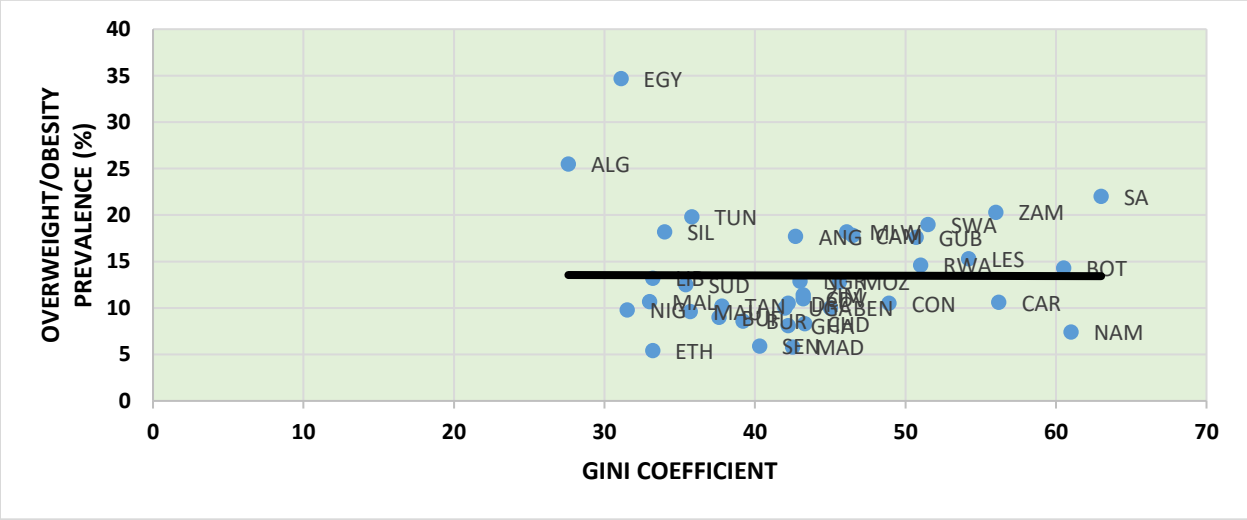
- '*While these countries continue to deal with the problems of infectious diseases and undernutrition, they are also experiencing a rapid upsurge in non-communicable disease risk factors such as obesity and overweight, particularly in urban settings.*
- *It is not uncommon to find undernutrition and obesity co-existing within the same country, the same community and the same household.*

Children in low- and middle-income countries are more vulnerable to inadequate pre-natal, infant, and young child nutrition. At the same time, these children are exposed to high-fat,

high-sugar, high-salt, energy-dense, and micronutrient-poor foods, which tend to be lower in cost but also lower in nutrient quality. These dietary patterns, in conjunction with lower levels of physical activity, result in sharp increases in childhood obesity while undernutrition issues remain unsolved" (WHO, 2018).

Pursuing the query of the relationship between income distributions, as measured by the GINI Coefficient reveals no clear association between national income distribution and the two opposing malnutrition indicators.[3]

Figure 3: Relationship between income distribution and obesity/overweight

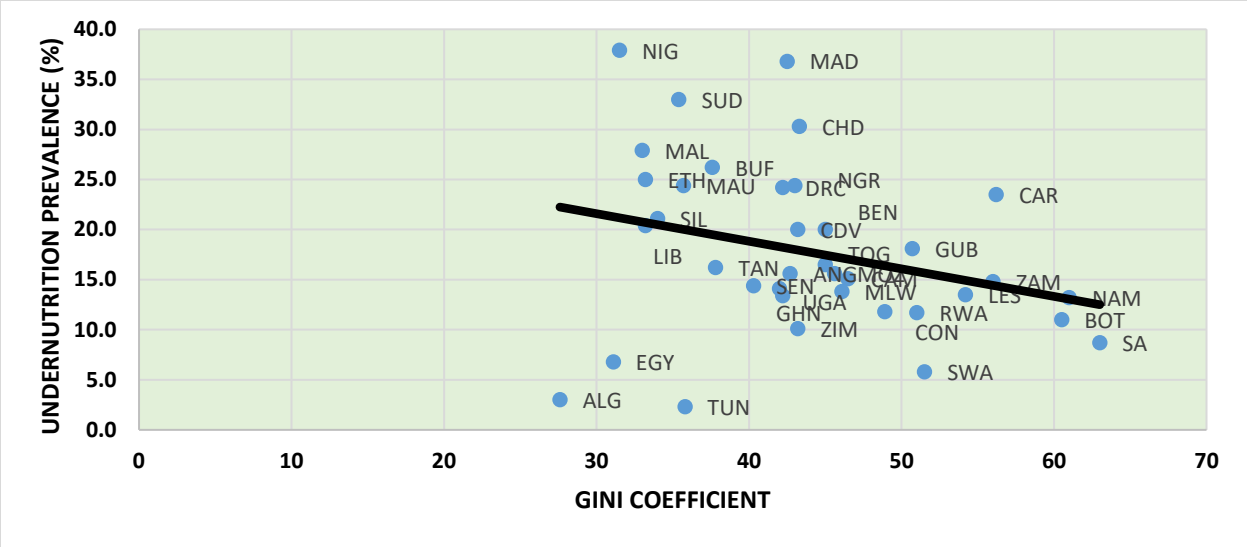


There is poor correlation between GINI Coefficient and Overweight/obesity; with a correlation coefficient of -0.00516, which is insignificant.

The relation between the GINI Coefficient and undernutrition is also low, with a correlation coefficient of -0.28479. This means that the higher the level of income inequality the lower the undernutrition levels, but only marginally. This relationship is shown in Figure 4 below. This observation is ambiguous.

Figure 4: Relationship between income distribution and undernutrition

[3] The Gini coefficient measures the inequality among values of a frequency distribution (for example, levels of income). A Gini coefficient of zero expresses perfect equality, where all values are the same (for example, where everyone has the same income). A Gini coefficient of 1 (or 100%) expresses maximal inequality among values (e.g., for a large number of people, where only one person has all the income or consumption, and all others have none, the Gini coefficient will be very nearly one)



There is an explanation for this and this. Food in general has a low-income elasticity of demand. *Descriptive statistics indicate that food demand is more responsive to changes in income (in other words, income elasticities are higher) for beverages, meat, fish and eggs and dairy, compared to foods that tend to constitute basic diets (e.g. cereals, legumes and nuts, fruit and vegetables, and fats and oils, tubers). Correspondingly, certain nutrient elasticities (especially elasticities of demand for proteins) are found to be higher than calorie elasticities. (European Commission, 2015).*

From the correlation analysis we proceed to run the regression as explained in the methodology section.
The results of the regressions analysis are shown in the Table 1 below:

Table 1: Regression Results Summary

Analysis 1 (OLS Regression)	
GINI ((Y_i)	Coefficients (β_i)
Obesity (x_i).	-0.189
Undernourishment (x_i).	-0.004
Analysis 2 (OLS Regression)	
GDP ((Y_i)	Coefficients (β_i)
Obesity (x_i).	0.324
Undernourishment (x_i).	-0.666*
Analysis 3 (OLS Regression)	
GDP ((Y_i)	Coefficients (β_i)

Obesity (x_i).	0.327
Undernourishment (x_i).	-0.652*
GINI (x_i).	0.731
Analysis 4 (Logit Regression)	
GINI ((Y_i)	Coefficients (β_i)
Obesity (x_i).	-0.0987451
Undernourishment (x_i).	-0.0001871

**Significant at 5% Levels*

The results in the Table above show little evidence of a strong relationship between income inequality as a driver of both undernourishment and overnutrition. The coefficients are both small and insignificant. This means there is no evidence that higher levels of malnutrition (both undernutrition and overnutrition) are associated with income inequality, at least using the data that was found. These results are consistent with the findings of Van de Poel et. al (2008) who found that in almost all countries investigated, stunting and wasting disproportionately affected the poor. However, socioeconomic inequality in wasting was limited and was not significant in about one third of countries. After correcting for the concentration index's dependence on mean malnutrition, there was no clear association between average stunting and socioeconomic inequality.

However, GDP per Capita shows evidence of being a strong driver of malnutrition. The results show that a 1% increase in GDP per capita for a given country result in increase in obesity by 0.3% and decrease malnutrition by up to 0.7%. GDP growth is shown to have a greater impact on undernourishment that over-nourishment, both in terms of the value of the percentage changes and the associated significance of the elasticity in terms of its p-value. These results are similar even after controlling for income inequality. All these results are consistent with the correlation coefficients between the variables as presented in the earlier analysis. These finding are consistent with Steven, et. al., (2012) who used cross-sectional studies of countries to conclude that fostering economic growth was the best way to fight malnutrition.

These findings are not surprising given that food tend to have low income elasticities. As income increase, the effect on overnutrition is not that big given that food consumption saturates and

tend to be reflected in food choices. Also, as nations increase their income, there is also increase in education and awareness on food choices. The combination of these factors means that GDP growth will tend to bring more positive impact on undernourishment that overnutrition, even though GDP growth also fuels overweigh or obesity.

The results are consistent with an observation by the World Bank Report (2015) which stated that higher incomes do improve nutrition—but only slowly and that a doubling of GNP per capita in developing countries has, on average, improved child underweight rates only from about 32% to about 23%. Shorter routes are providing health and nutrition education and services (such as promoting exclusive breastfeeding and appropriate complementary feeding, coupled with prenatal care and basic maternal and child health services) and micronutrient supplementation and fortification. Programs aimed at directly reducing malnutrition attack a core manifestation of non-income poverty and contribute strongly to income-poverty reduction, through their effects on economic growth and productivity. Further, it is now observed that good nutrition is a driver for economic development and not vice versa.

These observations are also in line with Uauy, R., et. al., (2001), who concluded that defining the right combination of foods/ nutrients, education and lifestyle interventions that are required to optimize nutrition and health. Growth at 5 percent per year would more than double real GDP per capita over the period and reduce the expected prevalence of stunting by as much as 20 percentage points (O'Connell and Smith, USAID, 2016)

6. Conclusion

The relationship between national income and malnutrition prevalence is as expected. Countries that have higher income tend to have higher prevalence of obesity/overweight. The opposite relationship holds for undernutrition. Countries with higher income tend to have lower levels of undernutrition. However, these relationships are not very strong, with a correlation coefficient of less than 50% in both cases. This is because higher income does not guarantee good nutrition and that there is friction in the response of undernutrition to growth in GDP. There is no significant relationship between income inequality and malnutrition prevalence. What is

consistent from the regression analysis is that higher national income does result in reduction in national undernutrition prevalence. Therefore, it is important to lobby governments to mainstream food and nutrition security in programmes that increase national income rather than focussing on agriculture in isolation. This will ensure that an increase in national income translates to reduction in malnutrition prevalence. Efforts must also be directed at shorter routes are providing health and nutrition education and services (such as promoting exclusive breastfeeding and appropriate complementary feeding, coupled with prenatal care and basic maternal and child health services) and micronutrient supplementation and fortification.

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