

## Hunger and Malnutrition: Review of Copenhagen Consensus Challenge Paper 2004



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### ABSTRACT

This paper reviewed Copenhagen challenge paper on hunger and malnutrition in 2004 alongside opponents' perspectives. The original challenge paper identified direct cost of malnutrition on health such as low birth weight and macronutrients deficiencies among children between ages 0-5 year. Indirect cost on economy such as low productivity due to poor cognitive development among children and absence of adult workers from work due to illness from poor nutrition were also identified. However, the original challenge paper significantly failed to address factors that could have led to the prevalence of malnutrition and hunger while proffering solution to these challenges. Hence, this paper empirically examine the relationship between undernutrition and these factors which include level of economic development, household income, access to improved water and level of calories intake. A cross section dataset of 52 developing countries for the year 2011 were analysed, the correlation matrix table and scattered graph plot results show that there are fairly strong negative correlation between malnutrition proxy by prevalence of undernutrition and (i) household income (poverty) proxy by GNI per capita; (ii) economic development proxy by GDP per capita and (iii) Access to improved water. However, the correlation between undernutrition and depth of calories deficit proved very strong and was positive. Thus, more attention need to be given to macroeconomic policies that will improve the life of the people in the economy and alleviate poverty. Basic amenities such improved and portable water should also be provided for the populace especially in developing countries where incidence of malnutrition are prevalence.

**Keywords:** Copenhagen consensus, Malnutrition and hunger, Cross section analysis, Opponents' perspectives.

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## 1. INTRODUCTION

The consequences of hunger and malnutrition such as maternal death and micronutrient deficiencies (low birth weight, underweight, stunting and severe wasting) have been widely discussed in several literatures. However, combating these challenges among others had gone beyond just writing an academic paper. Thus, every four year since 2004, many economists and academic scholars always have the opportunity to produce a more practicable and feasible paper to solve several challenges facing the world today which include hunger and malnutrition on the platform of Copenhagen consensus.

### **1.1. Aims of the Study**

This paper aims to review the Copenhagen consensus challenge paper on hunger and malnutrition 2004, the opponents' view, the comments from the panel, key theoretical backgrounds and policy issues. It will also cover an empirical research on couple of hunger and malnutrition challenges not addressed and/or partially addressed by the challenge paper and those issues raised by the opponents.

### **1.2. Objectives of the Study**

In a more succinct manner, this paper has the following specific objectives:

- a) To examine the direction and strength of correlation between under-nutrition and level of household income
- b) To investigate the direction and strength of correlation between under-nutrition and level of economic development
- c) To examine the direction and strength of correlation between under-nutrition and access to improved water
- d) To investigate the direction and strength of correlation between under-nutrition and calories intake deficiency

The rest of the study are as follows: section two briefly reviews the challenge literature which covered the challenge paper itself, opponents and panels' comments, as well as key theoretical and policy issues; section three discusses data and methodology employed; section four deals with analysis and findings; section five, conclusion.

## **2. REVIEW OF LITERATURE**

### **2.1. Challenge Paper- [Behrman et al. \(2004\)](#)**

The authors started the challenge paper by firstly described the nature and measurement of hunger and malnutrition. They describe the nature of these challenges as the lack of basic food intake with necessary nutrients and energy that could support productive lives. However, according to Hunger Task Force report, the nutrients provided by food combine with other factors and health status of the persons taken the food are used to measure their nutritional status (as cited in [Behrman et al. \(2004\)](#)).

The prevalence of anaemia among pre-school children is also an indicator of measuring malnutrition but this is due to micronutrient deficiency such as lack of iron which normally cause low haemoglobin ([Behrman et al., 2004](#)). Also Diarrhoea, fevers and some infections could occur as a result of Vitamin A deficiency. Apart from life severe damage to the status of any children with micronutrient deficiencies, they are also vulnerable to maternal death. [Haddad \(2013\)](#) estimates 2.3 million children died in 2011 because they were undernourished.

### **2.2. The Opportunities, Benefits and Costs**

The four opportunities with benefits and costs identified are discussed below:

#### **2.2.1. Reduce Prevalence of Low Birth Weight (LBW)**

The main objective of this opportunity is to reduce LBW among infant. As mentioned in the previous section above, LBW is intrauterine growth retardation resulting from short maternal stature, poor maternal nutrition before or during pregnancy, infection and smoking.

Table-1. Summary of Benefit and Costs for Opportunity 1

Opportunities and targeted populations	Benefits	Costs	Benefits/ Costs	Discount Rates	Other Remarks
1. Reducing LBW for pregnancies with high probabilities LBW (particularly in S.Asia)					
1a. Treatments of women with asymptomatic bacterial infections	\$580-986	\$200-2000	0.58-4.93	3-5%	
1b. Treatment for women with presumptive STD	\$580-986	\$92-460	1.26-10.71	3-5%	
1c. Drugs for pregnant women with poor obstetric history	\$580-986	\$28-280	4.14-35.20	3-5%	

Source: Alderman and Behrman (as annexed in Behrman *et al.* (2004))

As it can be inferred from table 1 above, the intervention programme mainly take form of: (1) Treatments for women with asymptomatic bacterial; (2) Treatments for women with presumptive STD; and (3) Drugs for pregnant women with poor obstetric history. Other policy programmes include: exclusive breastfeeding promotion and provision of micronutrient supplements such as Vitamin A, Iron, Zinc and Folate. They use plausible assumption and Present Discounted Value (PDV) approach at 3% to 5% discount rates to arrive at benefits-cost in the magnitude of \$580 per infant.

However, benefits include: reduced mortality and morbidity rate are direct benefits while economic benefits include: (1) saving of resources in reducing mortality and cost on neonatal care; (2) increased labour productivity as a result of low mortality and morbidity rate which will enhance schooling.

### 2.2.2. Infant and Child Nutrition and Exclusive Breastfeeding Promotion

This opportunity aims to promote integrated child care and intensive pre-school programmes with considerable nutrition for poor families. As mentioned in opportunity 1, authors also include promotion of breastfeeding in hospital in which norm has been promotion of use of infant formula.

The benefits here are similar to those mentioned under opportunity 1. However, mortality and health care costs are expected to reduce. Also, cognitive development and improved nutritional stature will increase schooling rate and reduce number of repeaters in school. The benefit-cost can be seen in the table below:

Table-2. Summary of Benefit and Cost for Opportunity 2

Opportunities and targeted populations	Benefits	Costs	Benefits/ Costs	Discount Rates	Other Remarks
2. Improving infant and child nutrition in populations with high prevalence of child malnutrition (fairly widespread in poor populations in developing countries)					
2a. Breastfeeding promotion in hospitals in which norm has been promotion of use of infant formula	\$131-134	\$133-1064	4.80-7.35	3-5%	
2b. Integrated child care programs	\$376-653	\$40	9.4-16.2	3-5%	
2c. Intensive re-school program with considerable nutrition for poor families			1.4-2.9	3-5%	

Source: Alderman and Behrman (as annexed in Behrman *et al.* (2004))

Improved in water and sanitation as well as Investments in women's education are also expected to convey benefits in terms of reduced malnutrition and health care cost.

### 2.2.3. Reducing the Prevalence of Deficiencies of Iron, Vitamin A, Iodine and Zinc

The main objective of this opportunity is to reduce micronutrient deficiency among children under six years old and to also target the same among women within child bearing age.

Table-3. Summary of Benefit and Cost for Opportunity 3

Opportunities and targeted populations	Benefits	Costs	Benefits/ Costs	Discount Rates	Other Remarks
3. Reducing micro nutrient deficiencies in populations					b
3a. Iodine (per woman of child bearing age)	\$75-130	\$0.25-5.0	15-520	3-5%	c
3b. Vitamin A (pre child under six years)	\$37-43	\$1-10	4.3-43	3-5%	
3c. Iron (per capita)	\$44-50	\$0.25	176-200	3-5%	
3d. Iron (pregnant women)	\$82-140	\$10-13.4	6.1-14	3-5%	c

Source: Alderman and Behrman (as annexed in Behrman *et al.* (2004))

However, targeting women within child bearing age with necessary micronutrient supplements as mentioned in table 3 above will lead to reduction in "LBW – that will manifest in terms of birth outcome and cognitive functions" (Behrman *et al.*, 2004). The benefit-cost of making this micronutrient supplements available per child under six year and woman of child bearing age are highlighted in the table 3.

### 2.2.4. Investment in Technology in Less Develop Country Agriculture

The objective of the authors here is to provide opportunities that will improve method of farming in order to grow high yield grains with enriched micronutrients. The idea here is not just to make food available but must be the one that will improve nutrition status.

Table-4. Summary of Benefit and Cost for Opportunity 4

Opportunities and targeted populations	Benefits	Costs	Benefits/ Costs	Discount Rates	Other Remarks
4. Investment in technology in developing agriculture					
4a. Dissemination of new cultivars with higher yield potential			8.8-14.7	3-5%	
4b. Dissemination of iron and zinc dense rice and wheat varieties			11.6-19	3-5%	
4c. Dissemination of Vitamin A dense rice, 'Golden Rice'			8.5-14	3-5%	

Source: Alderman and Behrman (as annexed in Behrman *et al.* (2004))

As it can be inferred from table 4 above, improved cultivars could increase genetic material in seeds that will permits high yield grain. Table 4 above shows the benefits-to-cost evaluation of the intervention programme and benefits as highlighted by the authors.

### 2.3. The Opponents' Perspectives- Simon Appleton and Svedberg (2004)

The major criticisms received by this challenge paper hovering around the evaluation methods used in arriving at the benefits-costs figures on which challenge papers were ranked by the panel. Other general issues like poverty, famine and hunger were also claimed to have been ignored or less discussed. Some other intervention instruments of alleviating under-nutrition were also reported to have been overlooked.

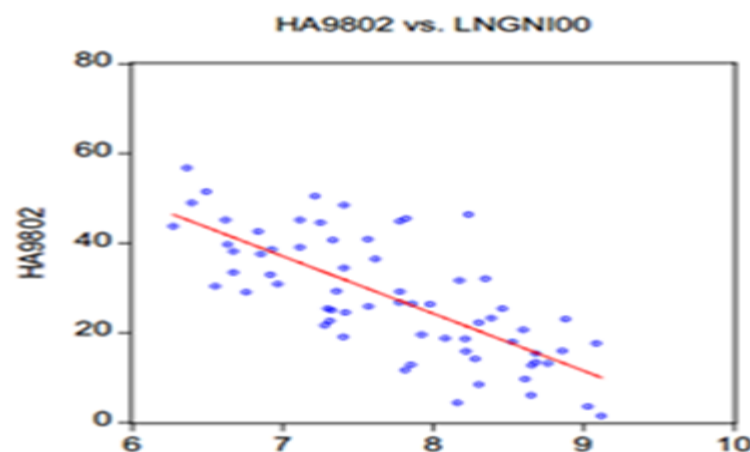
#### 2.3.1. Evaluation Methods

Appleton (2004) argued that empirical literatures upon which authors draw their evidences are rather fragmentary and partial which often drawing on developed country's data and frequently subject to serious methodological limitations.

For instance, Appleton argued further that, the derivation of some of the key figures are often unclear and sometimes reflect assumptions based on judgement. Even though he did not totally agree that these judgements appear flawed or biased in a particular direction but the tentative nature of the empirical evidence and consequent uncertainty over key magnitudes may warrant discounting the estimates by some arbitrary "risk premium". This sometimes tend to understate or overstate benefit-cost figures.

#### 2.3.2. Under-Nutrition and Poverty

Svedberg (2004) argued that less attention was given to the link between poverty, hunger and malnutrition. However, bivariate regression was run between prevalence of child stunting (children under 5 years with height below normal) and log of GNI per capita of 67 developing countries for 1998-2002 period. The relationship was negative and statistically significant at the 0.000 level with adjusted R square of 0.536.



**Figure-1.** The relationship between prevalence of child stunting (children under 5 years with height below normal) and Log of GNI er capita of 67 developing countries between 1998 and 2002  
 Source: Svedberg (2004)

From the above scattered graph, Svedberg therefore drawn conclusion that per-capita economic growth is very low in many developing countries and even negative in some cases, hence, households cannot (on average) exert stronger effective demand for essential private consumption goods, including more and nutritionally better food. He however suggests that the search for improved micro-level interventions and targeting methods must continue, but caution that in the absence of higher economic

growth rates in the poor countries, there is scant hope for realising the Millennium objective of alleviating the prevalence of child under-nutrition.

### 2.3.3. Other Intervention Instruments

Svedberg (2004) argued that child health and under-nutrition are intimately inter-related. He added that some child ill health reduction instruments such as immunisation against TB, DPT, polio and measles, oral rehydration therapy and child disease control practices (e.g treated malaria bed-nets and improved drugs) could have been included in opportunity 2 by the authors. According to him, child health can be improved upon by applying and further promoting the above mentioned intervention instruments.

The idea of Svedberg here is that these intervention instruments are quite less expensive and efficient going by their viral application in 1990s in many developing countries. The fact that, these interventions sometimes come in form of aid from international organisations and require less effort and money to administer them, then the authors should have included them in their opportunity 1 and 2.



### 2.3.4. Famine and Hunger

Appleton (2004) understood that the authors may be naive about famine in this challenge paper probably due to the fact that this might have been partly addressed by opportunities for reducing civil conflict considered in a companion challenge paper. According to him, famine appears increasingly to be aftermath of conflict or war and therefore suggests interventions to reduce risk of famine such as contingencies for emergency food-for-work schemes.

## 2.4. Comments by The Panel

The panel then choose to rank 17 out of 38 solutions, as they found there were insufficient information on the others. They divided the 17 solutions into “Very Good,” “Good,” “Fair” and “Bad” projects.

**Table-5.** The Dream Team’s Priorities of 17 Solutions to the World’s Greatest Challenges

<b>VERY GOOD PROJECTS</b>	
1.	Diseases: Control of HIV/AIDS
2.	Malnutrition: Providing micronutrients 
3.	Subsidies and Trade Barriers: Trade liberalization
4.	Diseases: Control of Malaria
<b>GOOD PROJECTS</b>	
5.	Malnutrition: Development of new agricultural technologies 
6.	Water and Sanitation: Small-scale water technology for livelihoods
7.	Water and Sanitation: Community-managed water supply and sanitation
8.	Water and Sanitation: Research on water productivity in food production
9.	Governance and Corruption: Lowering the cost of starting a new business
<b>FAIR PROJECTS</b>	
10.	Migration: Lowering barriers to migration for skilled workers
11.	Malnutrition: Improving infant and child nutrition
12.	Malnutrition: Reducing the prevalence of low birth-weight
13.	Diseases: Scaled-up basic health services
<b>BAD PROJECTS</b>	
14.	Migration: Guest-worker programs for the unskilled
15.	Climate: Optimal carbon tax
16.	Climate: The Kyoto Protocol
17.	Climate: Value-at-risk carbon tax

Source: Copenhagen Consensus Experts List (2004)

However, controlling HIV/AIDs was ranked number one with whopping sum of \$27billion followed by provision of micro-nutrients (i.e opportunity 3 of the challenge paper) as the second best solution to malnutrition with recommendation of \$12 billion to solve this problem.

A Nobel Laureate, Professor Douglass North of Washington University in Saint Louis was among the experts that recommended provision of micronutrients as number two on the priority lists of 2004 Copenhagen consensus result. According to him: "Today 3.5 billion people lack iron. It is extremely important to do something about malnourishment, especially among children. I give that proposal a very high priority." Development of new agricultural technology (opportunity 4) was also rated good and ranked number 5 best solution for global challenges.

## 2.5. Theoretical Concepts of Famine and Hunger

Sen (1981) came up with alternative approach to famine apart from availability approach. According to Brown and Eckholm (as cited in Sen (1981)) the traditional approach to famine is refers to FAD (Food Availability Decline). By this they mean, a sudden, sharp reduction in the food supply in any particular geographic location which usually resulted in widespread hunger and famine.

However, Sen argue through his entitlement approach that famine can still occur where there were no significant decline in the food availability. Osmani (1993) explained conceptual elements of Sen's entitlement approach to famine in a clearer manner. According to him, Sen's entitlement approach of famine are built upon three basic concepts, viz: the endowment set, the entitlement-mapping (or E-mapping, for short), and the entitlement set. Endowment set is the combination of all resources owned by a person 'legally' i.e in the course of social norms (e.g tangible assets-land, equipment, animal, etc., and intangible assets such as knowledge and skills, labour power, etc.). The entitlement set on the other hand, refers to all possible combinations of goods and services that a person can legally obtain through the resources of his endowment set. However, entitlement mapping or E-mapping (e.g farmer production: input-output ratio, labour exchange: wage rate-food price) is the link between endowment set and entitlement set.

Meanwhile, entitlement failure will occur when in the process of entitlement mapping, an individual cannot use his endowment set to meet the entitlement set, and then starvation begins. This will result to a famine when the starvation affects a large number of people in the society at the same time.

Devereux (2001) argued that Sen failed to elaborate four limitations of his entitlement approach. He therefore dug down those limitations to support his arguments. Devereux agree with Sen that, household may 'choose to starve' themselves by rationing food consumption in order to protect endowment set (asset) but stressing that Sen failed to incorporate a situation whereby intra-household power relation could lead to 'choosing to serve others'. He also argued that Sen "failed to recognise individuals as socially embedded members of households, communities and states, as well as failure to recognize that famines are political crises as much as they are economic shocks or natural disasters".

The arguments of Sen and Devereux above show that, poverty may not necessarily lead to hunger as people may choose to starve themselves in order to protect their assets from being sold for food consumption. Furthermore, intra-household superiority relation can also lead to the way food might be rationed and therefore lead to dependent member being starved.

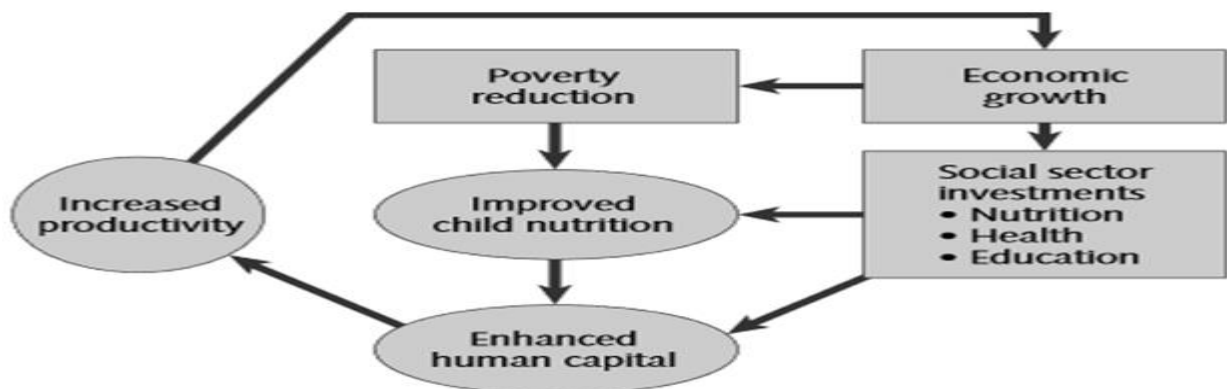


## 2.6. The Key Economic Implications

There are economic implications of hunger and malnutrition for countries where these two are prevalent. Apart from direct consequences such as stunting, underweight, and wasting, many economic losses have been identified as a result of these direct consequences.

According to [World Food Programme and UNICEF Report \(2006\)](#) Productivity losses to individuals are estimated at more than 10 percent of lifetime earnings while Gross domestic product (GDP) lost to malnutrition runs as high as 2 to 3 percent in some countries. The report further states that, many of the MDGs, including the goal for poverty reduction may not be achieved unless malnutrition is tackled.

The productive and cognitive gains of reducing malnutrition among children and adult have been linked with human capital development which in turn contribute toward economic development.



**Figure-2.** The relationship between improved child nutrition and economic development

Source: [Martorell \(1999\)](#)

Similarly, [Cleaver et al. \(2006\)](#) describe lost productivity per individual worker as method to estimate economic loss to a nation where malnutrition is prevalent. They also make reference to 2004 Food and Agricultural Organisation (FAO) report, where annual economic loss in Nigeria due to malnutrition in children under 5 in 1994 was estimated by this method and stood at \$489 million, or about 1.5 percent of GDP. Popkin and others (as cited by [Cleaver et al. \(2006\)](#)) estimated that obesity and related non-communicable diseases cost China about 2 percent of its GDP each year.

According to Gillespie et al. (as cited in [Martorell \(1999\)](#)) as well as relationship depicted in figure 2 above, investment in nutrition, health, and education programmes will enhance human capital through increased productivity and cognitive capability.

## 2.7. Policy Issues

The policy issue here is that looking at the relationships depicted in figure 2, there is need for government of the countries where these challenge of hunger and malnutrition are prevalent to embark on effective policies that will alleviate the challenge in the following areas:

1. **Education and health policies:-** As pointed out in figure 2, adequate and well targeted investment in social sector like health and education will improved child nutrition and enhanced human capital. This will overall lead to increased productivity i.e economic growth.
2. **Macroeconomic policies:-** Microeconomic policies that will improve the standard of living of the people in developing countries should be centre of focus. This is because there are some instances whereby GDP figures of some of these countries will actually look good but the populace



are actually wallowing in abject poverty. There is a link between poverty and malnutrition as suggested by [Svedberg \(2004\)](#).

### 3. RESEARCH DATA AND METHODOLOGY

#### 3.1. Data and Sources

The study used cross-section data of 52 developing countries for the year 2011 from world development indicator (WDI). Cross-section data of developing countries were chosen because they represent the areas where the challenge is more prevalent and 2011 will shed more light about what has happened since 2004 when the challenge paper was published.

#### 3.2. Data Description

The data collected and their description for the purpose of this study are shown in the table below:

**Table-6.** Variable Description

<b>Variables</b>	<b>Measured (Using data from WDI)</b>
Undernutrition	Prevalence of undernourishment (% of population)
Economic development	Log_GDP per capita
Household income	Log_GNI per capita
Access to improved water	Improved water source, rural (% of rural population with access)
Calories deficiency	Depth of the food deficit (kilocalories per person per day)

Source: World Development Indicator, [World Bank \(2015\)](#)

#### 3.3. Methodology

The study employed cross-section analysis with the use of descriptive statistics, scattered graph and bivariate correlation via Microsoft Excel. They are suitable methods in which objectives of the study set out in section one could be achieved. Also, [Svedberg \(2004\)](#) uses bivariate scattered graph to examine correlation between prevalence of child stunting (children under 5 years with height below normal) and log of GNI per capita of 67 developing countries for 1998-2002 period.

### 4. ANALYSIS OF FINDINGS

This section analysed and interpret the results of a new research on the links between under-nutrition, economic development, household income, access to quality water and low level of calories intake in 52 developing countries. It also aims to consolidate the contributions of 2004 challenge paper itself and the comments from the opponents.

#### 4.1. Descriptive Statistics

The descriptive statistics in table 7 below show that the number of observation (Count) comprises of 52 developing countries. The average (mean) percentage of people undernourished is 17.7% of the population, average kilocalories intake per person per day is 122.7 while the average percentage of rural dwellers having access to improved water source is 73.3%.

Table-7. Descriptive Statistics

Statistics	Prevalence of undernourishment	Log_GDP per capita	Log_GNI per capita	Improved water source	Calories intake deficiency
Mean	17.6788	7.2479	7.2479	73.3269	122.6538
Standard Deviation	10.7847	1.1156	1.1040	18.4293	85.4914
Range	40.10	4.53	4.69	65.70	325
Minimum	5.00	5.55	5.38	34.30	4
Maximum	45.1	10.08	10.08	100	329
Count	52	52	52	52	52

Source: Author's empirical results (2015) via Microsoft Excel

#### 4.2. Interpretation of Correlation Results to Validate the Research Objectives

Table 8 below is a correlation matrix table which shows the strength of the bivariate correlation between the variables of interest using the first column and the rows.

Table-8. Correlation Matrix

Variables	Prevalence of undernourishment	Log_GDP per capita	Log_GNI per capita	Improved water source	Calories intake
Prevalence of undernourishment	1				
Log_GDP per capita	-0.528665603	1			
Log_GNI per capita	-0.544347535	0.997679675	1		
Improved water source	-0.585677562	0.495577619	0.5197562	1	
Calories intake	0.976838598	-0.54914464	-0.564411	-0.58728	1

Source: Author's empirical results (2015) via Microsoft Excel

- a) Interpretation and analysis of results for objective number one- Direction and strength of correlation between under-nutrition and household income.

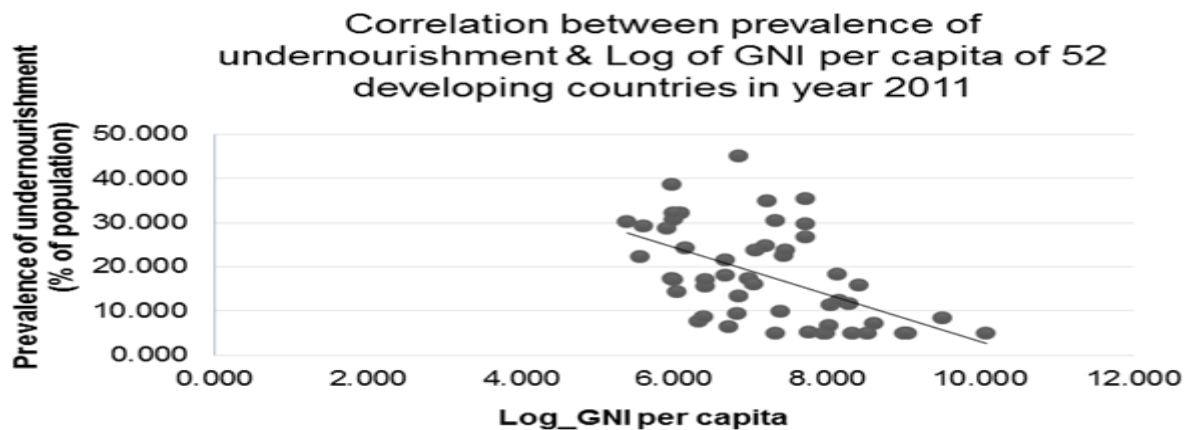


Figure-3. Correlation between prevalence of undernourishment and Log of GNI per capita of 52 developing countries in year 2011

Source: Author's empirical results (2015), via Microsoft Excel

The scattered graph and correlation table above depict a negative correlation between prevalence of undernourishment and log of GNI per capita and fairly strong with correlation coefficient of -0.54. This means that under-nutrition reduces as household income increases in these 52 developing countries investigated. However, looking at the scattered graph, few of these countries have undernourished

population below 20% with GNI per capita of 8% point and above while majority with undernourished population of 20% and above have GNI per capita below 8% point.

- b) **Interpretation and analysis of results for objective number two-** Direction and strength of correlation between under-nutrition and economic development.

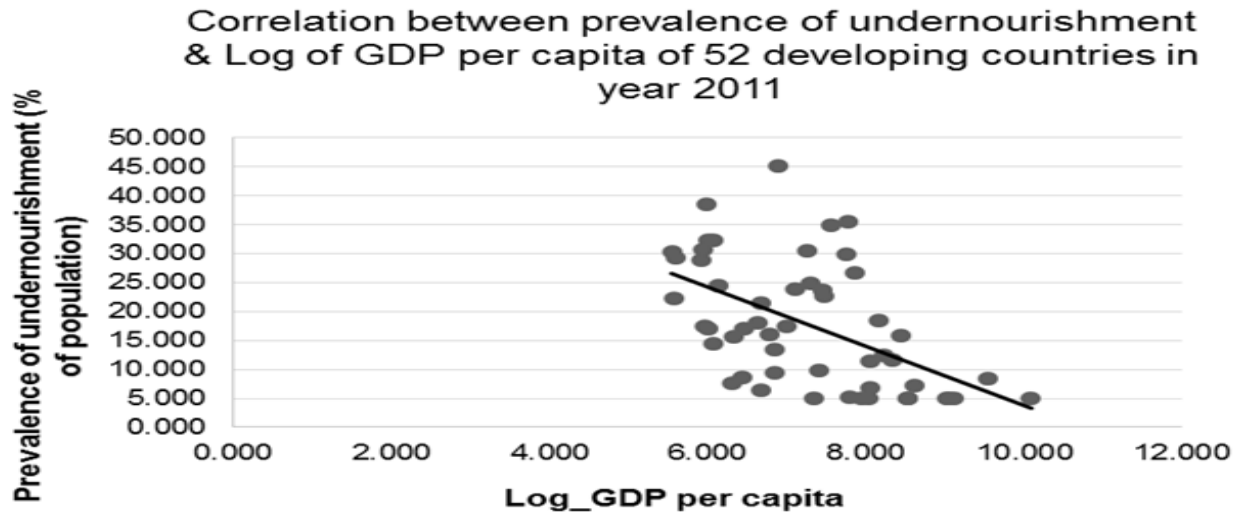


Figure-4. Correlation between prevalence of undernourishment and Log of GD per capita of 52 developing countries in year 2011  
Source: Author's empirical results (2015), via Microsoft Excel

The result here is almost the same with the first objective, still negative correlation which is fairly strong with -0.53 coefficient and statistically significant at 1% level. The implication is that as economy develop, the level of under-nutrition reduces. These two results consistent with (Martorell, 1999; Svedberg, 2004). This has to do majorly with overall improved standard of living and reduce poverty.

- c) **Interpretation and analysis of results for objective number three-** Direction and strength of correlation between under-nutrition and access to improved water.

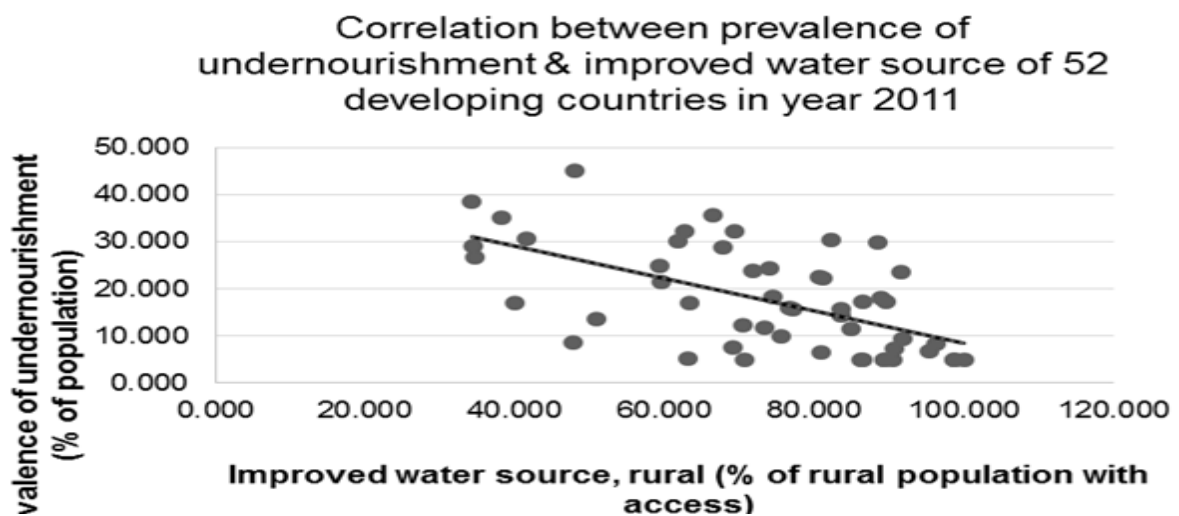
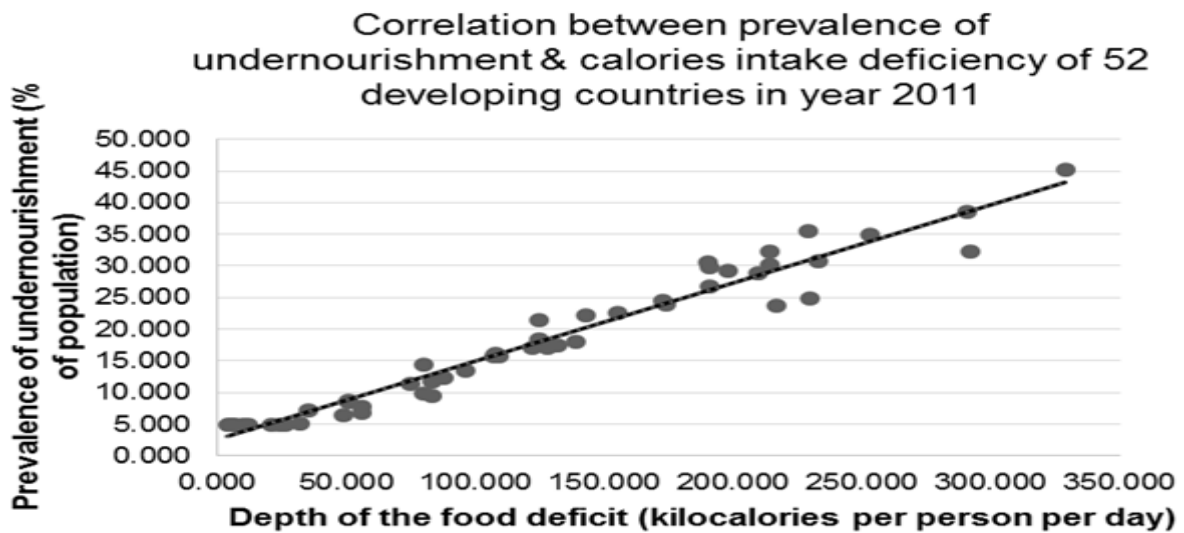


Figure-5. Correlation between prevalence of undernourishment and improved water source of 52 developing countries in year 2011  
Source: Author's empirical result (2015), via Microsoft Excel

The result also indicates a negative correlation between under-nutrition and access to improved water. The correlation is fairly strong as it can be depicted from table 9 with correlation coefficient of -0.59. This means that as the people in the rural area have more access to improved water source, under-nutrition reduces.

- d) **Interpretation and analysis of results for objective number four-** Direction and strength of correlation between under-nutrition and calories intake deficiency.



**Figure-6.** Correlation between prevalence of undernourishment and calories intake deficiency of 52 developing countries in year 2011  
**Source:** Author's empirical result (2015), via Microsoft Excel

The result from the scattered graph above shows that there is a very strong positive correlation between under-nutrition and low calories intake. The correlation coefficient is +0.98 as it can be inferred from table 9. This indicates that as calories intake deficiencies increases, under-nutrition also increases in these 52 developing countries investigated by the study. Calories intake deficiency may also cause productivity loss because of loss of energy require to perform piece of work.

## 5. CONCLUSION AND RECOMMENDATIONS

The empirical study carried out in this paper had been able to address part of the issues raised against 2004 challenge paper and also revealed other issues that need to be addressed. These are opportunities neglected or overlooked by challenge paper 2004. They include the link between under-nutrition; and economic development (i.e GDP per capita) (Appleton, 2004) improved water source, poverty (i.e household income-GNI per capita) and calories intake deficiency.

The findings of this study shows that there are fairly strong negative correlation between under-nutrition and economic development; household income (poverty) and improved water source while there is a very strong positive correlation between under-nutrition and calories intake deficiency. Thus, more attentions need to be given to these areas in subsequent challenge papers. However, if the four opportunities are well considered, the potential benefits as shown in the results of the study will be reduction in malnutrition.

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## Appendix-i

DATASET (WORLD DEVELOPMENT INDICATOR) FROM WORLD BANK DATABASE									
S/N	Country Name	GDP per capita (constant 2005 US\$)	Log_GDP per capita	GNI per capita (constant 2005 US\$)	Log_GNI per capita	Improved water source, rural (% of rural population with access)	Depth of the food deficit (kilocalories per person per day)	Prevalence of undernourish ment (% of population)	
1	Angola	2593.843	7.861	2238.877	7.714	34.700	191.000	26.700	
2	Azerbaijan	3088.282	8.035	2906.773	7.975	70.700	12.000	5.000	
3	Bangladesh	563.435	6.334	606.805	6.408	83.600	109.000	15.700	
4	Benin	552.594	6.315	551.385	6.312	69.100	56.000	7.700	
5	Bolivia	1217.746	7.105	1154.213	7.051	71.900	174.000	23.900	
6	Burkina Faso	462.924	6.138	462.748	6.137	74.100	173.000	24.400	
7	Cambodia	637.263	6.457	607.541	6.409	63.300	128.000	17.100	
8	Cameroon	942.524	6.849	931.208	6.836	51.000	96.000	13.500	
9	Chile	9029.734	9.108	8470.491	9.044	89.400	26.000	5.000	
10	China	3121.970	8.046	3093.500	8.037	84.900	75.000	11.400	
11	Colombia	4140.829	8.329	3934.473	8.278	73.400	83.000	11.700	
12	Congo, Rep.	1922.032	7.561	1356.985	7.213	38.200	253.000	35.000	
13	Costa Rica	5518.767	8.616	5440.963	8.602	90.700	35.000	7.300	
14	Cuba	5049.587	8.527	4978.782	8.513	86.400	7.000	5.000	
15	Dominican Republic	4663.876	8.448	4497.218	8.411	77.200	107.000	15.800	
16	Ecuador	3469.254	8.152	3407.567	8.134	74.500	125.000	18.400	
17	Egypt, Arab Rep.	1551.254	7.347	1511.514	7.321	98.800	10.000	5.000	
18	Gambia, The	432.467	6.070	416.628	6.032	83.700	80.000	14.400	
19	Guatemala	2305.893	7.743	2224.785	7.707	88.600	191.000	29.800	
20	India	1086.049	6.990	1076.620	6.982	89.500	132.000	17.400	
21	Indonesia	1650.555	7.409	1603.178	7.380	75.700	80.000	9.900	
22	Jordan	2827.126	7.947	2814.752	7.943	90.500	24.000	5.000	
23	Kazakhstan	5015.445	8.520	4133.014	8.327	86.200	4.000	5.000	
24	Lesotho	886.470	6.787	1132.570	7.032	76.600	108.000	16.100	
25	Liberia	256.868	5.549	218.005	5.385	61.900	214.000	30.200	
26	Madagascar	271.288	5.603	266.419	5.585	34.400	198.000	29.200	
27	Malawi	261.545	5.567	255.771	5.544	81.100	143.000	22.300	
28	Mauritania	626.665	6.440	594.523	6.388	47.700	51.000	8.700	
29	Mexico	8307.687	9.025	8182.231	9.010	89.300	5.000	5.000	
30	Mongolia	1473.602	7.295	1314.269	7.181	59.300	230.000	24.900	
31	Morocco	2432.824	7.797	2360.809	7.767	63.100	32.000	5.200	
32	Mozambique	395.658	5.981	390.423	5.967	34.300	291.000	38.600	
33	Nepal	384.772	5.953	386.943	5.958	86.500	126.000	17.400	
34	Pakistan	755.406	6.627	788.411	6.670	89.000	139.000	18.000	
35	Paraguay	1769.676	7.479	1687.689	7.431	80.700	155.000	22.600	
36	Peru	3760.857	8.232	3438.290	8.143	70.400	88.000	12.400	
37	Rwanda	372.288	5.920	369.067	5.911	67.900	210.000	28.900	
38	Senegal	793.674	6.677	784.468	6.665	59.500	125.000	21.500	
39	Seychelles	14016.458	9.548	13285.759	9.494	96.300	51.000	8.500	
40	Sierra Leone	383.507	5.949	399.092	5.989	41.500	233.000	30.700	
41	Sri Lanka	1724.812	7.453	1705.919	7.442	91.500	217.000	23.700	
42	Swaziland	2390.740	7.779	2232.906	7.711	66.500	229.000	35.500	
43	Tajikistan	437.222	6.080	433.950	6.073	62.700	292.000	32.200	
44	Thailand	3158.067	8.058	3040.948	8.020	95.300	56.000	6.800	
45	Togo	401.455	5.995	398.021	5.987	40.100	122.000	17.000	
46	Turkey	8413.318	9.038	8331.474	9.028	98.800	6.000	5.000	
47	Uganda	405.333	6.005	397.184	5.984	69.400	214.000	32.300	
48	United Arab Emirates	23907.076	10.082	23829.882	10.079	100.000	21.000	5.000	
49	Uzbekistan	793.299	6.676	824.323	6.715	80.900	49.000	6.500	
50	Vietnam	946.803	6.853	905.582	6.809	91.800	83.000	9.400	
51	West Bank and Gaza	1408.292	7.250	1509.123	7.319	82.300	190.000	30.500	
52	Zambia	986.453	6.894	932.731	6.838	48.100	329.000	45.100	

Source: World Bank (2015)

**Appendix-ii**

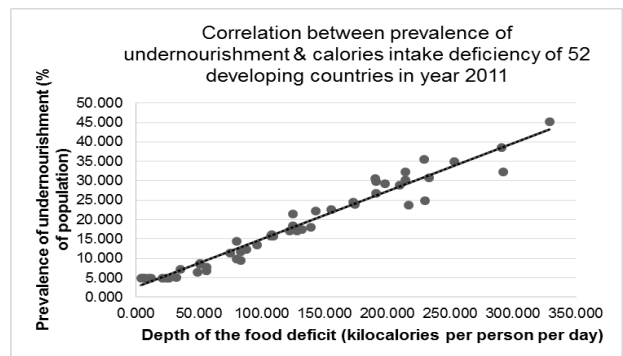
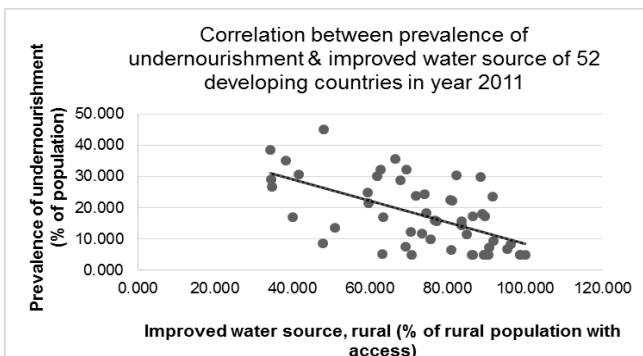
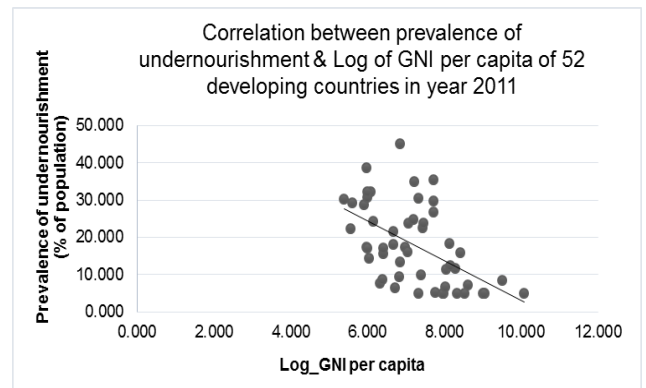
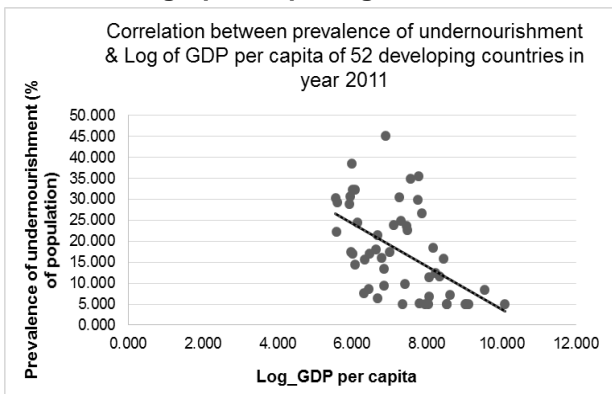
Descriptive statistics					
	Prevalence of undernourishment	Log_GDP per capita	Log_GNI per capita	Improved Water source	Calories intake Deficiency
Mean	17.6788	7.2788	7.2479	73.3269	122.6538
Standard Deviation	10.7847	1.1156	1.1040	18.4293	85.4914
Range	40.10	4.53	4.69	65.70	325
Minimum	5.00	5.55	5.38	34.30	4
Maximum	45.1	10.08	10.08	100	329
Count	52	52	52	52	52

Correlation matrix table					
	Prevalence of undernourishment	Log_GDP per capita	Log_GNI per capita	Improved Water source	Calories intake
Prevalence of undernourishment	1				
Log_GDP per capita	-0.528665603	1			
Log_GNI per capita	-0.544347535	0.997679875	1		
Improved Water source	-0.585677562	0.495577619	0.5197562	1	
Calories intake deficiency	0.976838598	-0.54914464	-0.564411	-0.58728	1

Source: Research results from Microsoft Excel

**Appendix iii**

**Scattered graphs depicting correlation between variables**



Source: Research results from Microsoft Excel

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