



REVIEW ON COST OF DIET ANALYSIS AS A TOOL FOR COMBATING MALNUTRITION IN NIGERIA



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Abstract: The paper titled “review on cost of diet analysis as a tool for combating malnutrition in Nigeria” attempts to highlight how Cost of the Diet – a method developed by Save the Children – can be utilized to mitigate the challenges of malnutrition in Nigeria. In order to achieve this, a desk review was conducted by exploring a database of literature on Cost of the Diet and malnutrition. It was found that as a method used for the purpose of estimating the amount and combination of local foods that are needed to provide individuals or a family with foods that meet their average needs for energy and their recommended intakes of protein, fat and micronutrients, several countries have used it to inform policy directions that could mitigate malnutrition. In consequence, this paper recommends that Nigeria should maximize the benefits inherent in the method to combat malnutrition.

Keywords: Cost of diet, diet analysis, malnutrition, save the children

Introduction

With an estimated population of approximately 206 million people, Nigeria is ranked as the most populous country in Africa (UNICEF, 2020). It is projected that by 2050, Nigeria's population would be 440 million – this will make it the third most populated country in the world, after India and China (National Bureau of Statistics, 2020). This is not without some challenges. One of which is inadequate food intake. It should be noted that inadequate food intake is a global public health challenge that is estimated to be the major cause of about 35% of all deaths during early childhood (Longhurst & Cornelius, 2013).

Retrospectively, it has been observed that malnutrition remains one of the most common causes of morbidity and mortality among children throughout the world. Approximately 9% of children below 5 years of age suffer from wasting (weight-for-height below 22 standard deviations [22 SD] of the National Center for Health Statistics [NCHS]/WHO reference values) and are at risk of death or severe impairment of growth and psychological development (World Health Organization, 1999). This could be compounded when cost of diet is not maximized optimally. The Cost of the Diet software was developed in 2005 with support from Save the Children so as to equip public health nutritionists and food security specialists to estimate the cost and affordability of meeting energy and nutrient specifications using local foods given that the software selects the most nutritious and least expensive food items (Deptford & Hall, 2017). One of the advantages of this tool is its ability to estimate the amount of a cash transfer to meet dietary specifications or to estimate the cost of the additional energy and nutrients needed during pregnancy.

However, in 2013 Save the Children began to redevelop the software in a more stable format. This led to review and update of underlying parameters that would provide a coherent scientific basis for the method. In the light of this, this paper which is primarily a desk review attempts to expound the place of cost of diet analysis as a tool for combating malnutrition in Nigeria. The sections that follow focus on malnutrition in Nigeria, cost of the diet, cost of the diet analysis as a tool for mitigating malnutrition in Nigeria, and conclusion.

Malnutrition in Nigeria

Food consumption is required to support human life (Chavas, 2017). Any deviation from normal food consumption patterns is regarded as malnutrition. Malnutrition is made apparent in deficiencies, excesses and imbalances in an individual's consumption of nutrients (World Health Organization (WHO), 2017). Malnutrition can be in the form of under nutrition (deficiencies) or over nutrition (excess) (Sufiyan *et al.*, 2012). However, this paper is basically concerned with malnutrition as deficiency of nutrition. Nutrient deficiency is one of major health challenges faced by children in developing countries (World Food Programme, 2006). Under nutrition leads to diseases and death in children, especially in the low and middle income countries (WHO, 2017).

In Nigeria, malnutrition makes the country lost billions in revenue through reduced economic productivity, days away from work as a result of illness and the money spent on treating ailments (World Bank, 2014). The negative impacts of malnutrition are seen in families and communities in their economic, social and medical spheres (WHO, 2017). As at 2013, one million children under 5 die every year in Nigeria, 35% of them due to causes attributable to malnutrition, making Nigeria one of the six countries that accounts for half of all child deaths from malnutrition worldwide (Longhurst & Cornelius, 2013). By 2017, the mortality rate has increased to an estimated 2.5 million. These children suffer from Severe Acute Malnutrition (SAM) every year – an extremely dangerous condition that makes children nine times more likely to die from common childhood illnesses such as diarrhoea, pneumonia and malaria (UNOCHA, 2017). In Katsina State for example, an estimate of 1.1 million children was threatened by severe acute malnutrition as a result of poverty, insecurity and lack of access to clean water (Tebeje *et al.*, 2017). Similarly, the eight years of violent conflicts by non-state armed groups across north-eastern Nigeria have severely weakened already fragile livelihoods thus exacerbating a deep humanitarian crisis. The insurgency made the three north-eastern states, Adamawa, Borno and Yobe, reach extremely high levels of food insecurity in 2016 (RPCA, 2016). In consequence, one out of three people in northeastern Nigeria (or 4.4 million people) is currently faced with acute food insecurity.

Table 1: The proportion of malnourished children (stunted, underweight or wasted) estimated for Nigeria, the three geopolitical zones in Northern Nigeria and selected states in Northern Nigeria

	% of Children 0-5 Stunted (-2sd)	% of Children Severely Stunted 0- 5 (-3sd)	% of Children Wasted 0-5 (-2sd)	% of Children Severely Wasted 0-5 (-3sd)	% of Children Under- weight 0-5 (-2sd)	% of Children Severely Under- weight 0-5 (-3sd)
Nigeria	41.0	23.0	14.0	7.0	23.1	9.0
NC	43.8	25.2	9.3	5.2	19.5	6.5
Nigeria NE	48.6	29.2	22.2	11.4	34.5	15.2
Nigeria NW	52.6	33.5	19.9	10.6	35.1	14.9
Nigeria Specific States						
Jigawa	53.4	34.3	34.4	17.5	51.1	25.5
Katsina	58.4	39.2	20.3	10.2	37.7	15.1
Kebbi	63.5	43.6	35.1	21.0	54.2	31.1
Yobe	54.0	34.5	20.9	9.2	39.4	15.3
Zamfara	54.0	33.2	11.3	4.9	18.3	5.5

Source: Longhurst & Cornelius (2013)

With the exception of the insecurity in most parts of the country, climate change is another cause of worsening malnutrition in Nigeria. The consequential increased temperature, intense heat waves, more extreme rainfall and floods are expected to intensify existing challenges of communicable diseases, food insecurity and poverty (WHO, 2015). Furthermore, basic causes for this include lack of government leadership or response to the crisis, coupled with a weak and fragmented health system, unable to provide the most basic cost effective services for the prevention and management of common health problems (Longhurst & Cornelius, 2013).

Malnutrition is more common in rural areas than urban areas. In addition, lack of formal education of parents especially mothers has also been shown to be a major contributory factor of malnutrition (Akombi *et al.*, 2017). Poor feeding practices as a result of ignorance about benefits of adequate breastfeeding and weaning practices also cause malnutrition (Sufiyan *et al.*, 2012). For example, children who fed with diluted cow milk for prolonged periods without other essential nutrients are prone to be malnourished (Tebeje *et al.*, 2017). Another cause of malnutrition is poor and inadequate health care service. Several studies showed a reduced use of health care facilities, as a result of obvious socio-economic inequality in Nigeria, as those in need of the facilities are located farther from it. Low maternal body mass index (BMI) and low birth weight contribute to malnutrition (Akombi *et al.*, 2017).

Children consuming food from polluted sources, such as drinking contaminated water from various sources such as rain water or spring water had higher incidence of under nutrition (Tebeje *et al.*, 2017). The nutritional quality of food consumption is paramount in driving the biological process that governs the growth and development of the musculoskeletal system and nervous system (Saarinen *et al.*, 2017).

Cost of the Diet

Cost of the Diet (CoD) is a method and software developed by Save the Children to estimate the amount and combination of local foods that are needed to provide individuals or a family with foods that meet their average needs for energy and their recommended intakes of protein, fat and micronutrients (Deptford *et al.*, 2017). The area where the CoD is most useful is in a situation when chronic under-nutrition and micronutrient deficiencies have been identified as nutritional problems in addition to a time when the availability or affordability of nutritious foods are likely to be among the

underlying causes. In consequence, utilizing the CoD tool engenders modeling of potential interventions to estimate impact on improving the quality and affordability of the diet. Here, the outcomes serve as veritable basis that influence food security and nutrition policies as well as programmes, in addition to contributing to advocacy. Results can also be used as an early warning indicator if the CoD is run regularly. This is not unconnected with the fact that the CoD software selects a variety of foods that would enable a family to meet their nutrient requirements.

The exposition made above implies that CoD considers nutrient indexes. It is apposite to underscore that nutrient indexes are formal systems to rank foods based on their nutrient content thus they give an indication of the extent to which different foods contribute to dietary recommendation (Ryan *et al.*, 2014). They form a basis for nutrient profiling, that is a scientific method aiming at assessing and categorizing foods according to their nutritional composition or healthiness. They value individual food products as a general source of nutrients. The index values refer to the healthiness of that food product compared to other food products. That kind of information can be used to help in achieving dietary recommendations.

In order to achieve its objectives, CoD software uses linear programming to calculate the amounts of locally available foods that would need to be consumed to meet specifications for energy, carbohydrates, protein, fats vitamins and minerals for any given individual or group of individuals at lowest possible cost.

The software application is limited to the total weight of each separate food to create a mixture that is similar to local dietary habits. The context of the diet here describes the foods selected by the software to meet the recommended intakes of energy and nutrients for a day, week, season or year, but limited in all calculations to prevent unrealistic amounts of foods being included and to prevent excessive amounts of some nutrients, to avoid toxicity.

The data needed to conduct an analysis, which is separated into cost and amount of nutrients provided in foods and the specification of people's intakes of energy and nutrients. The nutrient composition of foods, their portion sizes, and the energy and nutrient specifications of individuals are included within the software. If the affordability of the diet is to be estimated, income and expenditure data are required either from a primary source, such as the household economy approach (Boudreau, 2008), or from a secondary source.

Cost of the diet analysis as a tool for mitigating malnutrition in Nigeria

CoD can be used as a veritable instrument to mitigate the effects of malnutrition in the society. This is because the method enables public health nutritionists and food security specialists to estimate the cost and affordability of meeting energy and nutrient specifications using local foods considering the fact that the software selects the most nutritious and least expensive food available. Also the cost of food grown and consumed at home is included in the calculation by applying market prices. A menu driven software developed with the capacity to apply linear optimization routines in Microsoft Excel 2010 is used to select locally available foods to meet these nutrient requirements at the lowest possible cost. The Cost of the Diet software selects a mixture of foods that will enable a family to meet their energy and nutrient requirements as recommended by the WHO/FAO at the lowest possible cost. The approach provides basis for what is defined as a nutritious diet. The software can select amounts of foods that are not realistic in terms of the frequency with which foods are eaten, for example by specifying that a particular food is eaten three times a day every day, the frequency with which each food is consumed can be adjusted to reflect typical dietary patterns (Deptford, 2017). The cost of diet is useful when chronic under nutrition and micronutrient deficiencies have been identified as nutritional problems, and when the availability or affordability of nutritious foods is likely to be among the underlying causes. Using cost of the diet method allows the potential interventions to estimate impact on improving the quality and affordability of the diet which can influence food security and nutrition policies and programmes, and contribute to advocacy.

In a study conducted by Concern Worldwide (2017) using CoD software with particular emphasis on using price and weight data collected at Zambian markets, the cost of an energy-only diet, a nutritious diet, and a nutritious diet based on typical dietary habits was calculated for a family of five in each district. For instance it was found that the minimum cost of a diet that meets a household’s energy needs has been estimated at 7.18 ZMW per day in Sesheke and between 7.68 ZMW and 7.98 ZMW in Namwala depending on the season. The average monthly cost of the energy-only diet for a 5-person household is estimated to be 218 ZMW in Sesheke and 238 ZMW in Namwala District. The annual cost of the EO diet is 2,620 ZMW in Sesheke District and 2,851 ZMW in Namwala District. The implication of this is the CoD software can be used to generate accurate data that would inform policy formulation and practice change in Nigeria, particularly in North-east Nigeria where cash based transfers in respect of nutrition and livelihood are supported by International Non-Governmental Organizations and actors in the humanitarian sector. This will in a sense facilitate interventions based on accurate data instead of speculation.

A study was conducted by Save the Children in 2017 in Turkana, Kenya. The study aimed to identify whether a nutritious diet can be achieved using locally available foods, to estimate the cheapest cost of a nutritious diet, and whether this diet can be afforded by households in the Central Pastoral Livelihood Zone in Turkana County. In order to achieve the objective of the study, CoD software was used. The software was able to calculate a nutritious and food habits nutritious diet that met all the requirements of a standard household, meaning that there is sufficient diversity of foods in the region. However, the frequency with which these foods are available to households and the quantity with which these can be found in the markets is likely to be an obstacle to achieving a nutritious diet. Furthermore, the analysis found that between 215,000 KES and 285,000 KES are needed to close the

affordability gap and enable households to purchase a nutritious diet. It should be noted that Turkana is the poorest county in Kenya. The highest affordability gap was, surprisingly, identified for the middle wealth group, driven by the larger typical household size. Even though there was cash transfer going on at the county the course of the study, the study revealed that the cash transfer of 2,700 KES for very poor and poor household is not sufficient to close the affordability gap, although it reduces the deficit by 50% and 33% in each group, respectively (Save the Children, 2017). Thus, in the case of Nigeria running baseline assessments with CoD software before the commencement of intervention in SAM prone areas would serve a veritable for ensuring value for money and mitigation of malnutrition.

In Nigeria, Save the Children (2010) conducted cost of the diet assessment that calculated data without food frequency constraint in Daura LGA, Katsina State, Nigeria. Without food frequency constraints means foods available three times per day, seven days per week. Thus, Table 2 provides the findings.

Table 2: Food items selected in the lowest cost diet calculated without food frequency constraints for both children aged 12-23 months and the rest of the family for the low-price season

Food item	Child aged 12 – 23 months	Rest of the Family †
Breast milk	532	-
Millet, whole grain	39	559
Soybean	9	-
Coconut	60	1479
Baobab leaves, dried	14	360
Fish, small, dried	13	346
Cassava, dried	54	1848
Margarine	-	83

† NB these are the totals for all family members of 2 years old and above, but requirements per individual in this ‘rest of the family’ group are different (e.g. a 4-year old has different nutritional requirements than a 35-year old male adult)

Source: Save the Children (2010)

Table 3: The lowest daily and annual cost diet that meets only the energy requirements for an average very poor household (8 members) in Fika and Machina LGAs in Nigeria

Individuals	Season 1	Season 2	Season 3	Annual Cost
Dry season	Rainy season	Harmattan season		
12-23 month old child	13.59	16.45	13.83	5,427
Adolescent 14-15 years	72.81	92.37	72.33	29,511
Lactating woman	79.98	105.14	78.08	32,815
Rest of family	266.88	338.58	265.15	108,173
Total	433.27	552.54	429.39	175,926

Source: Save the Children (2018)

In a study conducted in Fika and Machina LGAs in Yobe State, the CoD software identified vitamin B12 as the most difficult to meet recommended intakes by considering the foods available in the market for the entire family (Save the Children, 2018). Iron was also considered as a limiting nutrient for specific groups within the households (lactating women, adolescents, and children 12-23 months). The software included baobab leaf, sorghum whole grain red, groundnut flour and wholegrain maize flour as the main sources of fat, protein, niacin, Vitamin A and C, calcium, iron, and zinc. It costs about 1.5 times as much money to meet recommended protein, fat and micronutrient requirements based on food habits compared with only meeting energy requirements. For instance, Table 3 and Table 4 indicate data sourced from CoD analysis conducted in Fika and Machina LGAs in Yobe State.

Table 4: The percentage of the average requirements for energy, protein and fat met each day by the food habits diet and the percentage of the recommended daily intake of vitamins and minerals provided by the diet for the 12 – 23 month old child in Fika and Machina LGAs

Food List	Qty (Kg)	% qty	Cost (₦)	% cost	% energy	% protein	% fat	% vit. A	% vit C	% vit B1	% vit B2	% niacin	% vit B6	% folic acid	% vit B12	% calcium	% iron	% zinc
Groundnut, flour, with fat	<1	0.3	232	2.9	1.5	2.5	3.6	0.0	0.0	2.9	0.6	2.3	1.2	1.0	0.0	0.2	0.8	1.3
Groundnut, red, shelled, dried, raw	3	0.9	796	10.1	4.7	6.5	10.9	0.0	0.0	9.1	1.8	11.1	3.7	3.1	0.0	0.5	1.4	4.6
Leaf, baobab, raw	39	13.2	1401	17.8	8.2	15.2	1.8	35.7	58.1	4.5	7.6	19.2	27.5	47.7	0.0	54.3	35.6	21.0
Leaf, baobab, dried	<1	0.2	102	1.3	0.5	1.0	0.1	0.4	0.4	0.3	0.5	1.1	1.7	2.5	0.0	3.7	2.4	1.4
Bhutta, shukna (Maize, yellow, dried, raw)	8	2.7	910	11.6	8.3	8.9	2.5	0.4	0.0	12.1	4.3	4.3	11.8	1.7	0.0	0.4	5.4	15.9
Breast milk	19	66.0	0	0.0	38.1	22.7	68.7	45.5	24.8	15.8	33.2	22.6	4.3	17.3	57.3	24.3	0.0	14.1
Busheshen Tumatir (Tomato, sundried)	2	0.6	334	4.2	1.3	2.6	0.4	0.3	2.0	3.3	3.9	4.0	1.3	1.2	0.0	0.8	3.5	2.0
Beef, kidney, raw	<1	0.2	639	8.1	0.2	1.0	0.1	1.0	0.2	0.7	7.1	1.1	0.8	0.5	42.7	0.0	2.8	0.6
Garin Masar or Garin Gero (Maize, flour, wholegrain, white)	21	7.0	1397	17.7	22.6	18.7	6.7	0.0	0.0	30.9	20.3	20.2	14.9	5.4	0.0	0.6	16.9	22.8
Gero (Millet, whole grain, raw)	7	2.3	741	9.4	7.2	8.3	2.5	0.0	0.0	8.0	4.4	3.2	11.8	2.1	0.0	1.1	15.4	6.1
Leaf, sesame, raw	14	4.7	689	8.8	1.5	5.7	0.2	16.7	14.5	4.8	12.8	4.8	17.6	15.0	0.0	13.0	10.1	3.3
Ridi (Sesame, seeds, whole, dried, raw)	<1	1	20	0.3	0.1	0.1	0.3	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.2	0.2	0.3
Sorghum, whole grain, white, raw	2	0.6	211	2.7	2.0	1.9	0.6	0.0	0.0	2.6	1.5	1.7	1.1	0.6	0.0	0.2	1.7	2.3
Sorghum, whole grain, red	3	1.1	325	4.1	3.2	3.7	0.9	0.0	0.0	3.8	1.6	4.2	1.5	0.5	0.0	0.4	3.1	3.1
Waken Suya (Soybean, dried, raw)	<1	0.1	78	1.0	0.5	1.3	0.6	0.0	0.0	1.0	0.5	0.2	0.7	1.5	0.0	0.4	0.7	1.1
Total	294	100	7876	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
% target met					100	182	100	146	286	141	112	170	232	175	100	122	100	110

Source: Save the Children (2018)

Given that economic constraints and cultural practices are exacerbating poor dietary diversity in the assessment area actors can utilize the findings sourced via the software to meet the nutrition needs via advocacy, extension service and partnerships with programmes working on nutrition and livelihoods. This is because a better understanding of the economic burden could help inform priority setting and motivate efforts to promote more effectively healthy diets and physical activity worldwide (Candari *et al.*, 2017). In addition to the above, food production varies greatly over space and depends on food products, prices, technology and local agro-climatic conditions (Chavas, 2017). Food consumption also varies across individuals/countries depending on tastes and preferences, prices and income distribution. In addition, individual access to food is complex. Overall, food insecurity varies over time and across space. It depends on food availability. Food insecurity develops in periods and locations where food scarcity occurs due to high food demand (e.g., from a rapid rise in population) and/or to food production shortfalls (e.g., from a drought). For this reason, CoD analysis is germane so as to ensure combat malnutrition in Nigeria. Even though there appears not to be any single or easy solution to tackle food and nutrition security fully, many of the challenges of ensuring global food and nutrition security cannot be adequately addressed without the participation of the research community (European Union, 2015). Cost of the Diet analysis is a research in its own right. This is because it has broken the concern on increasing food production to meet a growing demand, which used to be the focus of the past, to place more emphasis on how the nutrients on the available food in the community can be maximized to the utmost at low cost. Here the consciousness of stakeholders is raised to realize how a significant output of food production is lost or wasted. The society is made to realize that food consumption

patterns in combination with sedentary lifestyles can turn into significant and rising burdens on public health. Thus, it is of paramount importance to take a “food systems” view. This requires equal attention on improving agricultural and fisheries’ productivity, reducing the negative environmental impacts of production (including reducing emissions of greenhouse gasses), reducing waste at all stages in the food chain and in helping citizens eat more healthily. Thus in Nigeria, findings sourced from data collected as a result of the application of CoD software in different communities can be brought to bear to mitigate the growing risks of malnutrition, with the desired outcomes of improving economic growth, public health and the environment.

Conclusion

Malnutrition is a challenge in Nigeria. Available data reveal how severe acute malnutrition accounts for preventable child morbidity and mortality in Nigeria. However, it is envisioned that the cost of the diet method can be utilized to mitigate malnutrition in Nigeria. The Cost of the Diet is a method developed to check foods availability, nutrient sufficiency and food security in order to combat malnutrition. The Cost of the Diet analysis could be used to collect information and data from nutrition and food security surveys to inform nutrition, food security, livelihoods and social protection programmes delivered by development agencies; to inform and influence nutrition and food security related policy; and to inform advocacy processes and debates. This paper found that the cost of the diet software developed by Save the Children will allow practitioners to undertake standard Cost of the Diet assessments which could contribute to a new body of knowledge on the actual financial cost in both developing and developed countries of meeting human energy and nutrient specifications from inexpensive, locally available foods.

This paper concludes that CoD analysis should be prioritized to ensure that knowledge is generated across the complex global agri-food system with the highest positive impact for economic, public and environmental health. Here tool can be revalidated to align to complex nutrition challenges across multiple societal needs and across space (within and between states) in Nigeria. In order to achieve this, there is the need to promote a sophisticated and inclusive innovation culture building with local and international partnerships; particularly via facilitating a sustainable bio-economy and sharing related science and institutional knowledge internationally. Thus, improvement of communication and knowledge exchange that is inclusive and respectful of cultural complexity should not be neglected in the quest of using CoD analysis to combat malnutrition in Nigeria.

References

- Akombi B, Agho K, Hall J, Wali N & Renzaho AM 2017. Stunting, wasting and underweight in Sub-Saharan Africa: A systematic review. *Int. J. Envntal. Res. and Public Health*, 18, 863 – 878.
- Boudreau T 2008. *The Practitioners' Guide to the Household Economy Approach*. London: Save the Children.
- Candari CJ, Cylus J & Nolte E 2017. *Assessing the Economic Costs of Unhealthy Diets and Low Physical Activity: An Evidence Review and Proposed Framework*. London: Tetragon.
- Chavas J 2017. On food security and the economic valuation of food. *Food Policy*, 69: 58 – 67.
- Concern Worldwide 2017. *Cost of the diet analysis in two districts: Sesheke District, Western Province and Namwala District, Southern Province, Zambia*. Dublin: Concern Worldwide.
- Deptford A & Hall A 2017. *Cost of the diet: A practitioner's guide; version 2*. London: Save the Children.
- European Union 2015. *The Role of Research in Global Food and Nutrition Security: Expo 2015 EU Scientific Steering Committee Discussion Paper*. Brussels: European Union.
- Longhurst R & Cornelius A 2013. *Nutritional status in Northern Nigeria, prevalence and determinants: A review of evidence prepared for the ORIE component of the WINNN Programme*. Oxford: Oxford Policy Management, Clarendon House.
- National Bureau of Statistics 2020. *2019 poverty and inequality in Nigeria: Executive summary*, Abuja: NBS.
- RPCA 2016. *Food and Nutrition Insecurity in North-east Nigeria*. www.food-security.net
- Ryan KN, Adams KP, Vosti SA, Ordiz MI, Cimo ED & Manary MJ 2014. A comprehensive linear programming tool to optimize formulations of ready-to-use therapeutic foods: An application to Ethiopia. *Amer. J. Clin. Nutri.*, 100(6): 1551 – 1558.
- Saarinen M, Fogelholm M, Tahvonen R & Kurppa S 2017. Taking nutrition into account within the life cycle assessment of food products. *Journal of Cleaner Production*, 149: 828 – 844.
- Save the Children 2010. *Cost of diet assessment: Daura LGA, Katsina State, Nigeria*. Abuja: Save the Children.
- Save the Children 2017. *A Cost of the diet analysis in Turkana County, Kenya: Central Pastoral Livelihood Zone*. Nairobi: Save the Children.
- Save the Children 2018. *A Cost of the diet analysis in Yobe State in Nigeria*. Abuja: Save the Children.
- Sufiyan, M. B., Bashir, S. S. & Umar, A. A. (2012). Effect of maternal literacy on nutritional status of children under 5 years of age in the Babban-Dodo community Zaria city, Northwest Nigeria. *Annals of Nigerian Medicine*, 6: 61 – 64.
- Tebeje NB, Bikes GA, Abebe SM & Yesuf ME 2017. Prevalence and major contributors of child malnutrition in developing countries: Systematic review and meta analysis. *Journal of Childhood Obesity*, 2: 16 – 24.
- UNICEF 2020. Nigeria battles worsening nutritional crises. New York: UNICEF.
- UNOCHA 2017. *Global health observatory (GHO) data, overweight and obesity; Adults aged 18+*. New York: UNOCHA.
- World Bank 2014. *Costed plan for scaling up nutrition in Nigeria*. Washington DC: The World Bank.
- World Food Programme 2006. *Market profile for emergency food security assessments*. Rome: World Food Programme.
- World Health Organization 1999. *Management of severe malnutrition: a manual for physicians and other senior health workers*. Geneva: World Health Organization.
- World Health Organization 2015. Nutrient Profile Model. WHO Regional Office for Europe. Available at: http://www.euro.who.int/_data/assets/pdf_file/0005/270716/Nutrient-Profile-Model_Version-for-Web.pdf.
- World Health Organization 2017. Malnutrition fact sheet. WHO: Geneva.